4-1-2012

Arkansas Turfgrass Report 2010

Douglas Karcher
University of Arkansas, Fayetteville

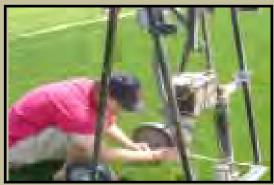
Aaron Patton
University of Arkansas, Fayetteville

Michael Richardson
University of Arkansas, Fayetteville

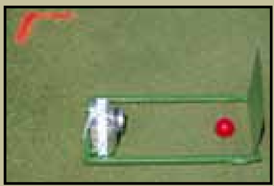
Arkansas Turfgrass Report 2010

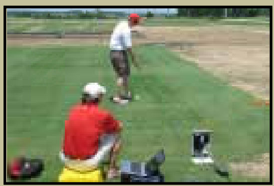
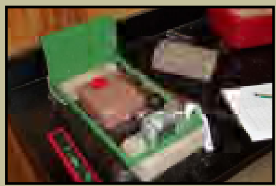
Douglas Karcher, Aaron Patton, and Michael Richardson, editors









DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

ARKANSAS AGRICULTURAL EXPERIMENT STATION

April 2012 Research Series 593

This publication is available on the Internet at: http://arkansasagnews.uark.edu/1356.htm

Technical editing, layout and cover design by Gail Halleck

Arkansas Agricultural Experiment Station, University of Arkansas System Division of Agriculture, Fayetteville. Mark J. Cochran, Vice President for Agriculture; Clarence E. Watson, AAES Director and Associate Vice-President for Agriculture–Research. WWW/InddCS5.

ISSN:1941-188X CODEN:AKAMA6

Arkansas Turfgrass Report 2010

Edited by:
Douglas Karcher, Associate Professor
Aaron Patton, Assistant Professor
and Michael Richardson, Professor

Department of Horticulture
University of Arkansas

University of Arkansas System Division of Agriculture
Arkansas Agricultural Experiment Station
Fayetteville, Arkansas 72701

Conversion Table

Conversions for commonly-used units in papers:

1 ft = 0.30 meters = 30.48 cm
1 inch = 2.54 cm = 25.4 mm
1 ounce = 28.3 g
1 lb = 0.454 kg = 454 g
1 PSI = 6.9 kPa
1 ppm = 1 mg / kg
1 gallon / acre = 9.35 L / ha
1 lb / 1000 ft^2 = 4.9 g / m^2
1 lb / 1000 ft^2 = 48.8 kg / ha
1 lb / 1000 ft^2 = 43.56 lb / acre
1 lb / acre = 1.12 kg / ha
1 bushel / 1000 ft^2 = 3.8 m^3 / ha
°F = (9/5*°C) + 32
°C = 5/9 * (°F-32)

To Our Colleagues and Constituents

Turfgrass Industry:

As the green industry continues to expand across Arkansas and the nation, the University of Arkansas Division of Agriculture has assembled an outstanding team of researchers, extension personnel, and educators that are working to solve some of the most pressing needs of that industry. One segment of that industry that continues to provide a significant impact on the state's economy is the turfgrass industry, which includes lawn care, parks, sports turf, sod production, and golf course maintenance. In a recent survey, it was estimated that the turfgrass and lawn care industry in Arkansas provides over 8,600 jobs and contributes over $336 million annually to the state's economy.

The Arkansas Turfgrass Report is a Research Series that is published annually by the Arkansas Agricultural Experiment Station and features significant findings made by turfgrass scientists during the past year. Although this publication primarily summarizes findings from the research program, it also highlights advancements in teaching and extension programs, as well as significant issues that affect the industry as a whole. It is our desire that this publication will keep our stakeholders abreast of significant changes and advancements that affect our industry.

We are very proud of this fourth installment of the Arkansas Turfgrass Report, which includes 18 papers from faculty, staff, and graduate students. We hope these findings will enhance your ability to conduct business in an efficient and productive manner. The content of this edition of the Arkansas Turfgrass Report has been organized into categories in the Table of Contents ("Cultivar Trials," "Turf Culture," "Pest Control," etc.) for your convenience.

We would also like to recognize the many organizations, companies, and individuals who have given their time, money, and talents to make our program successful. We are extremely grateful to the many people who contribute to this program.

We hope that this publication will be of value to all persons with an interest in the Arkansas green industry.

Doug Karcher
Associate Professor

Aaron Patton
Assistant Professor

Mike Richardson
Professor

University of Arkansas Turfgrass Research Cooperators

The University of Arkansas turfgrass research team is grateful for assistance in the form of donated equipment and product, and research grants from the following associations and companies. Our productivity would be significantly limited without this support.

Andersons Golf Products
Aquatrols, Inc.
Arkalite
Arkansas Farm Bureau
Arkansas Turfgrass Association
BASF
Bayer Environmental Science
Pat Berger, University of Arkansas Athletics
Casey Crittenden, Bella Vista POA
Conwed Fabrics
Crossover Liquor
Jason Cuddy, Springdale Country Club
DeWitt Company
Double Springs Grass Farm
Dow AgroSciences
DuPont
Environmental Turf
Ewing Irrigation
FMC Corporation
Georgia Pacific
Golf Course Superintendents Association of America
Golf Course Superintendents Association of Arkansas
Dr. Wayne Hanna, University of Georgia
Helena Chemical
ISK Biotech
Jacobsen (Textron)
Johnston Seed Co.
Lebanon Seaboard
Lee McBurnett, Stonebridge Meadows
Lentz Sand and Gravel
Jason Miller, The Blessings Golf Club
Milliken
Milorganite Chemical
Mississippi State University
Monsanto Company
Jerry Musick, Razorback Park Golf Course
National Turfgrass Evaluation Program
NexGen Research
Brandon Nichols, Fayetteville Country Club
North Carolina State University
OJ Noer Foundation
Patten Seed Co.
PBI Gordon
Pennington Seed
PermaGreen Supreme, Inc.
Precision Labs
Professional Turf Products
Profile Products Co.
Pure-Seed Testing
Quail Valley Sod
Quali-Pro
Scotts Professional Turf
Seed Research of Oregon
Seeds West, Inc.
Spectrum Technologies
Stillwater Equipment Co.
Syngenta
Texas A&M University
The Toro Company
Tifsport Growers Association
Todd Towery, Pinnacle Country Club
Turfgrass Producers International
United States Golf Association
University of Florida
Winrock Grass Farm

We regret that some individuals or companies may have been inadvertently left off of this list. If your company has provided financial or material support for the program and is not mentioned above, please contact us so that your company's name can be added in future reports.

Table of Contents

Cultivar Trials

Turf Culture

Establishment

Stress Tolerance

Pest Control

Weather

Report from the 2006 NTEP Tall Fescue Trial – 2010 Data

Mike Richardson[1], John McCalla[1] and Doug Karcher[1]

Additional index words: *Festuca arundinacea*, turfgrass, cultivars, quality, color, brown patch, density, coverage

Richardson M., J. McCalla and D. Karcher. 2012. Report from the 2006 NTEP Tall Fescue Trial – 2010 Data. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:9-15.

Photo by Mike Richardson

Diseases such as pythium causing damage to tall fescue cultivars.

Summary. Tall fescue is a very popular grass for lawn areas in northern Arkansas and throughout the transition zone. Identifying adapted cultivars for the region remains a central focus of the University of Arkansas turfgrass research program. The National Turfgrass Evaluation Program is the predominant means by which cultivars are tested throughout North America. A tall fescue cultivar trial, containing 113 entries, of which 60 are commercially-available cultivars, was planted in the fall of 2006 at Fayetteville, Arkansas. Cultivars were rated for turf color, overall turf quality, and turfgrass density during the early part of the 2010 growing season. A severe outbreak of brown patch, followed by one of the most severe summers on record in Fayetteville Ark., caused massive failure of most of the trial and plots were evaluated several times in late summer and fall for survival. The cultivars that had the highest overall survival following the 2010 growing season included Einstein, Padre, Ky-31, Aristotle, Shenandoah Elite, Gazelle II, Wolfpack II, AST 7003, 3rd Millennium SRP, Toccoa, Lindbergh, and Rhambler SRP. All other cultivars had less than 30% ground coverage in late fall.

Abbreviations: NTEP, National Turfgrass Evaluation Program

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Tall fescue (*Festuca arundinacea*) is one of the most popular cool-season turfgrasses in the transition zone regions of the United States and is widely used in lawns, sports fields and on utility turf in the region. Tall fescue is known for its superior drought tolerance, good shade tolerance, and ability to grow on poor soils relative to other cool-season grasses. Breeding efforts in the past three decades have made tremendous strides in improving the overall quality of this species.

The National Turfgrass Evaluation Program (NTEP) is an organization within the U.S. Department of Agriculture that annually oversees turfgrass cultivar evaluation experiments at various sites throughout the U.S. and Canada. Each turfgrass species is tested on a four to five year cycle at sites throughout the growing region for that particular species. The University of Arkansas has been an active participant in the NTEP and has conducted several tests on tall fescue cultivars over the past 20 years. This report summarizes the 2010 performance data, including turfgrass color, spring density, brown patch incidence, turfgrass quality, and turfgrass coverage for the NTEP 2006 National Tall Fescue Test at Fayetteville, Arkansas.

Materials and Methods

This cultivar experiment was conducted at the University of Arkansas System Division of Agriculture Research and Extension Center in Fayetteville. The plot size was 4 ft by 5 ft and there were three replications of each cultivar. Prior to seeding, the entire trial area was fumigated with methyl bromide and a pre-plant fertilizer (10-20-20) was applied at 10 lb/1000 ft^2 prior to seeding. One-hundred and thirteen tall fescue cultivars and experimental lines were broadcast planted on 2 Oct. 2006 at a seeding rate of 6 lb/1000 ft^2. Plots were maintained under lawn conditions throughout the duration of the study. Mowing height was maintained at 1.5 inch throughout the season with clippings returned. Four nitrogen applications were made during each growing season with 2.0 lb N/1000 ft^2 applied in November and 1.0 lb N/1000 ft^2 applied in April, June, and September. All N applications were made as urea (46-0-0). Irrigation was supplied as needed to promote establishment, maintain vigorous growth, and prevent drought stress.

Overall turf quality was evaluated monthly during the growing season. Quality was visually assessed on a 1 to 9 scale, with 9 representing ideal dark green, uniform, fine-textured turf and 1 representing dead turf. Turfgrass color was evaluated once during the 2010 growing season. Color was visually assessed on a 1 to 9 scale, with 9 representing ideal dark green color and 1 representing chlorotic conditions. Turfgrass coverage was determined periodically during the season using digital image analysis (Richardson et al., 2001). For this report, the only data that will be presented and discussed are from those cultivars (60 total) that were commercially available at the time this paper was published.

Results and Discussion

The 2010 growing season was noteworthy, in that Fayetteville experienced one of the most severe summers on record and temperatures were generally 2-6 degrees above average for most of the growing season (Richardson and Karcher, 2011). In addition, rainfall was lower than average for 8 months during 2010. (Richardson and Karcher, 2011). Differences in turf quality were present among cultivars on every rating date in 2010 and when averaged over the entire season (Table 1). In addition, differences in turfgrass color or spring density were also observed (Table 2).

Brown patch (*Rhizoctonia solani*) pressure is typically very high on tall fescue cultivar trials in Arkansas (Richardson et al., 2009) and a significant outbreak of brown patch was observed during early July on this trial (Fig. 1, Table 2). There was a wide range of cultivar responses, from cultivars with no brown patch to cultivars with up to 37% infection. Although many of these cultivars eventually succumbed to the severe heat stress during the 2010 season, the data collected on brown patch incidence should be helpful in selecting cultivars, since brown patch is one of the major limitations to tall fescue productivity in Arkansas.

The ongoing disease pressure and consistent high temperature stress observed during the latter half of the summer of 2010 caused massive failure of most of the trial (Fig. 2). In fact, the loss of turf was so severe that the trial had to be abandoned after the 2010 season even though plans were in place to collect data through 2011. Although turfgrass loss was significant on all the plots, the cultivars that had the highest overall survival following the 2010 growing season included Einstein, Padre, Ky-31, Aristotle, Shenandoah Elite, Gazelle II, Wolfpack II, AST 7003, 3rd Millennium SRP, Toccoa, Lindbergh, and Rhambler SRP. All other cultivars had less than 30% ground coverage in late fall. It is noteworthy that there was an almost 50% loss of coverage in the KY-31 plots, which has never been observed at this site in over 20 years of conducting tall fescue cultivar trials. KY-31 is a forage-type cultivar that is normally considered one of the most stress-tolerant cool-season grasses for our region and will rarely suffer coverage loss, especially when managed under irrigated conditions.

These data represent ongoing evaluations of tall fescue cultivars that will be marketed in this region in the coming years. Yearly summaries of the data from this site and all sites around the United States will be published by NTEP and be available at their website (www.ntep.org).

Literature Cited

Richardson, M., J. McCalla, D. Karcher, and A. Patton 2009. Report from the 2006 NTEP tall fescue trial–2007-2008 data. Arkansas Turfgrass Report 2008, Ark. Ag. Exp. Stn. Res. Ser. 568:105-109.

Richardson, M. and D. Karcher 2012. 2010 Weather Summary for Fayetteville, Arkansas. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:97-98.

Richardson, M.D., D.E. Karcher, and L.C. Purcell. 2001. Quantifying turfgrass cover using digital image analysis. Crop Sci. 41:1884-1888.

Table 1. Turfgrass quality for commercially-available tall fescue cultivars for the 2010 growing season in Fayetteville Ark. Cultivars are sorted based on average turfgrass quality for the growing season.

Entry	March	April	May	June	Avg.
	---------------- turfgrass quality[a] ---------------------				
Falcon IV	8.0	7.3	7.3	7.3	7.5
Compete	7.7	7.3	7.0	7.7	7.4
Turbo RZ	8.0	7.3	7.0	7.3	7.4
Hunter	7.7	7.7	7.0	7.0	7.3
AST 7001	7.7	6.7	7.3	7.7	7.3
Plato	8.0	7.0	7.0	7.3	7.3
AST 7003	8.0	7.3	7.0	7.0	7.3
Rhambler SRP	8.0	7.3	7.0	7.0	7.3
Firenza	7.3	7.0	7.3	7.7	7.3
Monet	7.7	7.0	7.0	7.3	7.3
Tahoe II	7.7	7.3	7.3	6.7	7.3
Speedway	7.7	7.3	7.0	7.0	7.3
Darlington	7.7	7.0	7.0	7.3	7.3
Reunion	7.7	7.3	7.0	7.0	7.3
AST 9002	7.7	7.0	7.0	7.3	7.3
RNP	8.0	7.3	7.0	6.7	7.3
Rebel IV	7.7	7.0	7.0	7.3	7.3
Cezanne Rz	7.7	7.0	7.3	6.7	7.2
Escalade	7.7	7.0	7.0	7.0	7.2
AST 7002	7.7	6.7	7.0	7.3	7.2
Shenandoah Elite	7.3	7.0	7.3	7.0	7.2
Honky Tonk	7.3	7.0	7.3	7.0	7.2
AST 9001	7.3	7.3	7.0	7.0	7.2
AST 9003	7.3	6.7	7.3	7.3	7.2
Silverado	7.7	6.7	7.3	6.7	7.1
Toccoa	7.7	6.7	7.0	7.0	7.1
Einstein	7.3	6.7	7.0	7.3	7.1
Essential	7.3	7.0	7.3	6.7	7.1
Talladega	7.7	6.3	7.0	7.3	7.1
SR 8650	7.7	6.3	7.0	7.3	7.1
LSD (0.05)	0.9	0.8	1.0	1.0	0.6

Entry	March	April	May	June	Avg.
	---------------- turfgrass quality ---------------------				
Rembrandt	7.7	6.7	6.7	7.3	7.1
Pedigree	7.3	7.0	7.0	7.0	7.1
Traverse SRP	7.3	6.7	7.0	7.3	7.1
RK 4	7.7	6.7	6.7	7.0	7.0
Hemi	7.7	6.3	6.7	7.3	7.0
Bullseye	7.3	7.0	6.7	7.0	7.0
Firecracker LS	7.3	6.7	7.0	7.0	7.0
Magellan	7.7	6.7	6.7	7.0	7.0
Shenandoah III	7.0	7.0	6.7	7.3	7.0
Wolfpack II	7.7	7.0	7.0	6.3	7.0
Justice	7.3	7.0	7.0	6.7	7.0
Hudson	7.3	6.3	7.0	7.3	7.0
Raptor II	7.7	7.0	6.3	6.7	6.9
Faith	7.3	6.7	6.7	7.0	6.9
Gazelle II	7.3	6.7	7.0	6.7	6.9
3rd Millennium SRP	7.0	6.7	6.7	7.3	6.9
Skyline	7.7	6.7	6.3	6.7	6.8
Turbo	7.0	6.7	7.0	6.7	6.8
Mustang 4	7.3	6.7	6.3	7.0	6.8
Falcon V	7.3	7.0	6.7	6.3	6.8
Tulsa III	7.3	7.0	6.3	6.7	6.8
Aristotle	7.3	6.3	6.7	6.7	6.8
Renovate	7.3	6.7	6.0	6.7	6.7
Lindbergh	7.0	6.3	6.3	7.0	6.7
Spyder LS	7.0	6.3	6.7	6.3	6.6
Titanium LS	7.0	6.3	6.7	6.3	6.6
Padre	7.3	6.3	6.0	6.7	6.6
Van Gogh	7.0	6.7	6.0	6.3	6.5
Biltmore	7.3	6.3	6.0	6.3	6.5
Ky-31	5.3	5.3	5.3	5.0	5.3
LSD (0.05)	0.9	0.8	1.0	1.0	0.6

[a] Turfgrass quality was rated on a scale of 1-9, with 9 considered optimum quality.

Table 2. Turfgrass color, density, brown patch incidence, and coverage for commercially-available tall fescue cultivars for the 2010 season in Fayetteville Ark. Cultivars are sorted based on the highest turfgrass coverage at the end of the growing season.

		Spring	Brown	Turfgrass coverage				Spring	Brown	Turfgrass coverage	
Entry	Color	Density	Patch	Summer	Fall	Entry	Color	Density	Patch	Summer	Fall
	1-9[a]	1-9[a]	%	%	%		1-9	1-9	%	%	%
Einstein	6.3	6.0	20.0	22.0	57.0	Cezanne Rz	6.5	6.3	0.0	3.3	16.3
Padre	6.5	6.7	13.3	42.7	53.3	Skyline	6.7	6.0	6.7	14.3	15.7
Ky-31	4.7	4.0	6.7	32.3	50.3	Talladega	6.7	6.0	6.7	2.7	15.3
Aristotle	6.7	6.3	10.0	31.0	43.7	RK 4	6.7	6.3	16.7	4.7	14.7
Shenandoah Elite	6.7	5.3	6.7	33.3	41.3	AST 9001	7.2	6.3	18.3	13.0	14.7
Gazelle II	6.3	6.0	3.3	41.0	41.0	AST 9003	7.2	6.3	3.3	9.7	14.7
Wolfpack II	6.7	6.3	10.0	21.3	36.7	Silverado	5.7	6.7	0.0	2.0	10.7
AST 7003	7.0	6.0	13.3	7.3	35.0	Falcon IV	6.5	5.7	20.0	4.7	9.7
3rd Millennium SRP	6.7	6.0	10.0	13.3	33.3	AST 9002	7.2	5.7	16.7	3.0	9.3
Toccoa	7.2	5.7	6.7	18.7	33.0	Renovate	7.3	5.3	33.3	1.7	8.7
Lindbergh	6.5	6.3	1.7	4.0	32.7	Firecracker LS	6.5	6.3	20.0	2.0	8.3
Rhambler SRP	6.3	5.3	30.0	12.3	30.3	Honky Tonk	6.8	5.7	10.0	2.7	7.7
Essential	6.3	5.7	13.3	23.7	29.7	Faith	6.8	6.0	36.7	3.3	7.3
Pedigree	6.7	6.3	23.3	27.3	29.3	Hunter	7.0	5.7	6.7	7.3	6.7
Biltmore	6.7	5.7	3.3	10.3	27.7	Traverse SRP	6.5	5.3	3.3	2.7	6.3
Compete	7.2	5.3	26.7	25.0	27.3	Raptor II	7.0	5.7	3.3	2.3	5.0
Justice	6.3	5.7	0.0	10.3	26.7	Tahoe II	6.8	5.7	5.0	1.0	5.0
AST 7002	7.0	5.7	10.0	22.0	26.3	RNP	7.2	6.3	1.7	2.3	5.0
Turbo	7.0	5.7	3.3	27.3	25.0	Titanium LS	6.5	6.0	3.3	2.0	4.7
Reunion	7.2	6.0	13.3	26.0	25.0	Firenza	6.8	5.7	13.3	2.0	4.7
Magellan	6.7	6.0	16.7	8.7	24.7	Van Gogh	6.3	5.7	16.7	1.7	4.0
AST 7001	7.3	5.3	30.0	27.7	24.3	Mustang 4	7.0	5.7	16.7	1.3	4.0
Darlington	7.3	6.0	16.7	9.0	24.0	Shenandoah III	6.5	6.0	16.7	0.7	3.0
Escalade	6.2	7.0	3.3	10.7	23.3	Rebel IV	6.5	6.0	23.3	1.0	2.0
Plato	6.3	6.3	6.7	8.0	22.3	Speedway	6.5	5.3	16.7	1.3	1.3
Turbo RZ	6.8	6.3	20.0	8.3	22.0	Rembrandt	6.3	5.7	6.7	1.0	1.3
Tulsa III	6.8	5.7	3.3	8.3	21.0	Hudson	7.2	5.7	6.7	0.3	1.3
Spyder LS	6.8	6.3	5.0	7.7	19.7	Monet	6.5	5.3	10.0	0.3	1.0
SR 8650	6.8	5.7	13.3	12.7	18.0	Hemi	6.8	5.7	20.0	0.7	1.0
Bullseye	6.7	5.3	26.7	6.0	17.0	Falcon V	6.5	5.7	13.3	0.3	0.7
LSD (0.05)	0.5	1.6	27.9	30.6	45.1	LSD (0.05)	0.5	1.6	27.9	30.6	45.1

[a] Turfgrass color and density were rated on a scale of 1-9, with 9 being considered dark green genetic color and optimum turfgrass density.

Fig. 1. Brown patch pressure noted on 15 July 2010, on the 2006 NTEP tall fescue trial.

Fig. 2. Catastrophic loss of turf in the 2006 NTEP Tall fescue trial – photo taken on 29 July 2010.

2007 NTEP Bermudagrass Trial – Year 4 Results

Mike Richardson[1], Doug Karcher[1], and Aaron Patton[2]

Additional index words: *Cynodon dactylon, Cynodon dactylon x C. transvaalensis*, turfgrass, cultivars, quality, color, spring green-up, leaf texture, seedheads

Richardson, M., D. Karcher, and A. Patton. 2012. 2007 NTEP Bermudagrass Trial – Year 4 Results. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:16-20.

Photo by Mike Richardson

Bermudagrass cultivar plots showing differing amounts of seedheads.

Summary. Bermudagrass continues to be the prevailing turfgrass species used in Arkansas for golf courses, sports fields, home lawns and utility turf situations. Identifying adapted cultivars for the region remains a central focus of the University of Arkansas turfgrass research program. The National Turfgrass Evaluation Program (NTEP) is the predominant means by which cultivars are tested throughout North America. A bermudagrass cultivar trial was planted in the summer of 2007 at Fayetteville, Ark. This trial has been maintained under typical lawn conditions and data on spring green-up, overall quality, leaf color, leaf texture, and seedhead formation were collected during 2010. Average turf quality across months for the year was highest for Tifway, Premier, OKC 1119, Tiftsport, Tifway, Patriot, Tifgreen, SWI-1113, Tift-11, Midlawn, OKC 1134, OKS 2004-2, and SWI-1057. Turf quality for the year was lowest for PSG-91215, PSG-94524, Sunsport, and Numex Sahara, which is similar to 2008 data. Future evaluations over the next two years will provide a more complete picture of cultivars that perform best under these management and climate conditions.

Abbreviations: NTEP, National Turfgrass Evaluation Program

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701
[2] Purdue University, Department of Agronomy, West Lafayette, Ind. 47907

Bermudagrass (*Cynodon* spp.) remains the most commonly used turfgrass on golf courses, sports fields, and lawns in Arkansas and throughout southern and transition zone environments. Bermudagrass has many positive attributes that have made it a successful turfgrass species, including good heat and drought tolerance, pest resistance, traffic tolerance, and tolerance to a wide range of soil types and water quality.

The National Turfgrass Evaluation Program (NTEP) is an organization within the U.S. Dept. of Agriculture that annually oversees turfgrass cultivar evaluation experiments at various sites throughout the U.S. and Canada. Each turfgrass species is tested on a four-to-five year cycle at sites throughout the growing region for that particular species. The University of Arkansas has been an active participant in the NTEP and has conducted several tests on bermudagrass cultivars since 1986. This report will describe the data collected in 2010 for the 2007 NTEP bermudagrass trial at Fayetteville, Ark.

Materials and Methods

The majority of the bermudagrass entries in this trial were planted on 9 June 2007 at the University of Arkansas System Division of Agriculture Research and Extension Center in Fayetteville. Some additional entries were planted in August for comparison over the life of the trial (Table 1). Plot size was 7 by 8 ft and there were three replications of each cultivar. Vegetative cultivars were planted as 2 inch diameter plugs on a 12 inch spacing within the plots, while seeded cultivars were broadcast planted at a seeding rate of 1.0 lb/1000 ft^2. Plots were maintained under typical lawn, sports field, or golf course rough conditions, with a mowing height of 1.5 inch, and monthly applications of 1.0 lb N/1000 ft^2 during the growing season. Irrigation was applied as needed to prevent drought stress.

Overall turf quality was evaluated monthly during the growing season. Quality was visually assessed on a 1 to 9 scale, with 9 representing ideal dark green, uniform, fine-textured turf and 1 representing dead turf. Cultivars were visually evaluated for spring green-up using a scale of 1 to 9, with 9 representing complete green color and 1 representing a completely dormant turf stand. Density was rated on a scale of 1 to 9, with 9 representing maximum density. Texture was rated on a scale of 1 to 9, with 9 representing fine leaf texture. Seed head density was evaluated using a scale of 1 to 9, with 9 representing heavy seed head production and 1 representing no visible seed heads.

Results and Discussion

On the first rating date, spring green-up was similar among all cultivars although there were a few cultivars that were statistically different from each other (Table 1). On 28 April 2010, more dramatic differences in spring green-up were observed. Cultivars that had the best green-up on this rating date included the vegetative cultivars, Tifgreen, Tifway, GN-1, Quickstand, OKC-1119, and OKC 1134, and the seeded cultivars, Riviera, OKS 2004-2, RAD-CD1, PSG 9Y2OK, SWI-1081 and Yukon (Table 1).

Turf density was generally highest for cultivars established vegetatively compared to those established by seed (Table 1). Turfgrass density was greatest for OKC 1119, OKC 1134, and Tifway and least for PSG-91215 and Numex Sahara. Turfgrass color was greatest for Tifway, GN1, and Patriot and leaf texture was greatest for OKC1119, Premier, OKC 1134 and Tifway (Table 1). Seed heads were generally greatest in seeded cultivars (Table 1). Cultivars with a high incidence of seedheads included PST-R6EY, PST-R6ON, PST-R6FLT, and Sunsport. Cultivars with the fewest seed heads in September were Midlawn, OKC1119, and Tifsport (Table 1).

Turfgrass quality in 2010 varied for each cultivar by month (Table 2). Average turf quality across months for the year was highest for Tifway, Premier, OKC 1119, Tifsport, Tift-11, PSG 9Y2OK, SWI-1113, Patriot, Tifgreen, GN1, Riviera, Yukon, OKS 2004-2, Quickstand, OKC 1134, RAD-CD1, Midlawn, SWI-1070, Princess-77, and Veracruz. Turf quality for the year was lowest for Numex Sahara, PSG-91215, Sunsport, PSG-94524, and PST-R6ON.

These ratings were collected on three-year old plots and should be reliable, but use caution as shifts in cultivar performance are typical in these trials as the plots age and are subjected to various stresses. Additionally, these plots are maintained at 1.5 inch, which is common for a home lawn or sports field and may not compare well to previous data collected at our location at a lower mowing height of 0.5 inch (Patton et al., 2008). It was noteworthy that significant winterkill was observed on other trials at this location in 2010 (Richardson et al., 2011), but there was no winterkill observed in the present trial, likely due to the high mowing height compared to previous bermudagrass trials at this location. Future evaluations will provide a more complete picture of the cultivars that perform best under these management and climate conditions.

Literature Cited

Patton, A., M. Richardson, D. Karcher, J. McCalla and J. Landreth. 2008. 2002 NTEP bermudagrass trial – summary. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:33-36.

Richardson, M., D. Karcher, and A. Patton. 2012. Winterkill in the 2007 Arkansas Zoysiagrass Trial. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:26-29.

Table 1. Spring green-up, color, density, texture and seed head ratings in 2010 for various vegetative (veg) or seeded (seed) bermudagrass cultivars in Fayetteville, Ark.

Cultivar	Planting Method	Green-up[a] 12-Apr	Green-up 28-Apr	Color[b] 31-Aug	Density[b] 31-Aug	Texture[b] 31-Aug	Seedheads[c] 17-Sep
BAR 7CD5	Seed	2.0	6.0	6.7	5.0	5.7	6.0
Celebration[d]	Veg	1.3	5.7	6.3	7.0	6.0	2.0
GN-1[d]	Veg	1.3	6.7	7.7	6.7	6.3	3.0
IS-01-201	Seed	2.0	5.7	5.7	5.3	5.7	5.3
IS-CD10	Seed	2.0	6.0	6.0	5.7	5.3	6.3
J-720	Seed	2.0	6.0	6.3	5.3	6.3	5.0
Midlawn	Veg	2.0	6.3	5.7	7.0	7.7	1.3
NuMex-Sahara	Seed	2.0	4.7	5.0	3.3	5.7	6.7
OKC 1119	Veg	1.7	6.7	7.3	9.0	9.0	1.3
OKC 1134	Veg	2.0	7.7	7.0	8.3	8.3	1.7
OKS 2004-2	seed	2.0	6.3	6.0	5.7	6.3	3.3
Patriot	veg	1.7	5.7	7.7	7.0	7.3	2.3
Premier	veg	1.3	6.3	7.3	7.7	8.7	2.3
Princess 77	seed	1.0	4.0	6.0	5.3	6.3	6.3
PSG 91215	seed	1.3	5.3	5.7	3.7	6.0	7.3
PSG 94524	seed	2.0	5.7	6.7	4.7	5.0	7.3
PSG 9BAN	seed	2.0	6.0	6.3	4.7	6.0	6.3
PSG 9Y2OK	seed	2.7	6.3	6.7	5.7	6.7	5.3
PSG PROK	seed	2.0	5.7	6.7	5.0	6.0	7.0
PST R6EY[d]	seed	1.7	6.0	5.0	4.7	5.7	8.7
PST R6LA[d]	seed	1.3	5.3	5.0	5.3	6.0	7.3
PST R6ON[d]	seed	1.7	5.7	5.0	5.7	5.7	8.0
PST-R6FLT	seed	1.3	5.7	5.3	6.3	6.0	8.0
Quickstand[d]	veg	2.3	6.7	4.3	6.0	5.3	5.3
RAD-CD1	seed	2.3	6.0	5.7	5.0	6.0	5.0
Riviera	seed	2.7	7.0	6.3	5.3	6.7	3.7
Sunsport	seed	1.7	4.7	4.7	4.0	4.7	7.7
SWI-1057	seed	1.7	4.7	6.0	5.7	6.7	5.0
SWI-1070	seed	1.3	6.0	6.0	5.7	6.7	5.0
SWI-1081	seed	1.7	6.3	5.0	5.3	5.0	5.3
SWI-1083	seed	2.0	6.0	6.3	4.3	6.0	5.0
SWI-1113	seed	1.7	5.0	6.3	6.3	6.7	3.7
SWI-1117	seed	2.0	5.7	5.3	4.3	5.3	7.0
SWI-1122	seed	2.0	5.7	5.7	4.7	6.3	5.0
TifGreen[d]	veg	2.0	7.7	5.7	7.7	7.3	3.7
Tifsport[d]	veg	1.0	6.7	7.0	7.7	7.3	1.3
Tift-11	veg	1.0	5.7	6.3	6.7	7.0	2.0
Tifway	veg	1.3	6.7	7.7	8.0	8.0	1.7
Veracruz	seed	1.3	4.0	6.0	5.7	6.3	4.7
Yukon	seed	2.3	6.0	6.7	6.0	6.7	4.7
LSD(0.05)		0.7	1.0	1.4	1.0	1.1	1.5

[a] Spring green-up was visually evaluated for bermudagrass cultivars using a scale of 1 to 9, with 9 representing complete green color and 1 representing a completely dormant turf stand.

[b] Turfgrass color, density, and texture was rated on a scale of 1 to 9, with 9 representing dark color, high density, or fine leaf texture.

[c] Seed head density was evaluated using a scale of 1 to 9, with 1 representing no visible seed heads.

[d] Cultivars not part of the official trial and were added as either locally-available standards or additional entries from a breeder.

Table 2. Turf quality ratings in 2010 for various vegetative (veg) or seeded (seed) bermudagrass cultivars in Fayetteville, Ark. Cultivars are sorted by average yearly turfgrass quality from highest to lowest.

	Planting	Turfgrass quality[a]					
Cultivar[b]	Method	May	June	July	Aug.	Sep.	Average
Tifway	veg	6.3	7.3	7.0	7.3	7.0	7.0
Premier	veg	6.7	7.0	7.0	7.3	7.0	7.0
OKC 1119	veg	7.0	6.0	7.3	7.3	7.3	7.0
Tifsport [b]	veg	6.3	7.3	6.3	7.3	7.0	6.9
Tift-11	veg	6.3	7.0	6.3	7.7	7.0	6.9
PSG 9Y2OK	seed	5.0	7.3	7.0	7.7	7.3	6.9
SWI-1113	seed	5.3	7.0	7.0	7.3	7.7	6.9
Patriot	veg	5.7	7.3	6.7	7.3	7.0	6.8
TifGreen[b]	veg	6.3	6.3	6.7	7.3	7.0	6.7
GN-1[b]	veg	6.0	7.3	6.3	7.3	6.3	6.7
Riviera	seed	5.3	7.3	6.3	7.3	7.0	6.7
Yukon	seed	5.0	7.0	6.7	7.7	6.7	6.6
OKS 2004-2	seed	5.3	7.3	6.0	7.3	7.0	6.6
Quickstand[b]	veg	5.7	6.7	6.7	7.3	6.7	6.6
OKC 1134	veg	6.7	5.7	6.7	7.0	7.0	6.6
RAD-CD1	seed	5.3	7.0	6.0	7.3	6.7	6.5
Midlawn	veg	6.3	6.3	6.7	6.7	6.3	6.5
SWI-1070	seed	4.3	7.3	6.7	7.0	7.0	6.5
Princess 77	seed	4.7	7.0	6.3	7.3	6.7	6.4
Veracruz	seed	4.7	6.3	6.7	7.3	7.0	6.4
Celebration[b]	veg	5.7	6.0	6.0	7.0	6.7	6.3
SWI-1083	seed	4.7	7.0	6.0	6.7	7.0	6.3
SWI-1057	seed	5.3	6.3	6.0	7.0	6.7	6.3
PST-R6FLT	seed	5.3	6.7	6.0	6.7	6.7	6.3
IS-CD10	seed	5.0	6.7	6.3	6.7	6.7	6.3
J-720	seed	5.0	7.0	5.7	7.0	6.7	6.3
SWI-1122	seed	5.0	6.3	6.3	7.0	6.3	6.2
PST R6LA[b]	seed	5.0	6.7	6.0	6.7	6.7	6.2
SWI-1081	seed	5.0	5.7	6.3	7.0	7.0	6.2
IS-01-201	seed	5.0	6.3	5.7	7.0	7.0	6.2
SWI-1117	seed	4.7	6.3	5.7	7.0	6.3	6.0
PSG PROK	seed	4.3	6.3	5.7	7.0	6.7	6.0
PST R6EY[b]	seed	5.0	6.0	5.0	7.0	7.0	6.0
BAR 7CD5	seed	4.0	6.0	6.0	7.0	6.7	5.9
PSG 9BAN	seed	4.3	6.0	5.7	7.0	6.7	5.9
PST R6ON[b]	seed	5.0	5.3	5.7	6.3	6.3	5.7
PSG 94524	seed	4.0	6.0	6.0	6.3	6.0	5.7
Sunsport	seed	4.0	5.3	5.0	6.7	6.3	5.5
PSG 91215	seed	4.3	5.3	5.3	6.0	6.0	5.4
NuMex-Sahara	seed	4.0	5.3	5.0	6.0	5.7	5.2
LSD (0.05)		0.9	1.2	0.9	1.0	0.8	0.6

[a] Turf quality rated on a scale of 1 to 9 (9= ideal dark green, uniform, dense, fine-textured turf, 1=dead).
[b] Cultivars not part of the official trial and were added as either locally-available standards or additional entries from a breeder.

2007 NTEP Seashore paspalum Trial – Year 4 Results

Mike Richardson[1], Doug Karcher[1], and Aaron Patton[2]

Additional index words: *Paspalum vaginatum*, turfgrass, cultivars, quality, color, spring green-up, leaf texture, seed heads, winter-kill, cold tolerance

Richardson, M., D. Karcher, and A. Patton. 2012. 2007 NTEP Seashore paspalum Trial – Year 4 Results. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:21-25.

Photo by Mike Richardson

Dormant seashore paspalum (foreground) plots at Fayetteville, Ark.

Summary. Seashore paspalum is a relatively new turfgrass species being evaluated for use in Arkansas for golf courses or sports fields. Identifying adapted cultivars for the region remains a central focus of the University of Arkansas System Division of Agriculture turfgrass research program. The National Turfgrass Evaluation Program (NTEP) is the predominant means by which cultivars are tested throughout North America. A seashore paspalum cultivar trial was planted in the summer of 2007 at Fayetteville, Ark. This trial has been maintained under typical golf course fairway conditions and data on spring green-up, winterkill, coverage, leaf color, leaf texture and fall color retention were collected in 2010. This trial was significantly damaged by severe cold temperatures during the 2009/2010 winter and all cultivars had significant loss of turfgrass coverage. The cultivar, Salam, survived the winter better than other cultivars, but still had over 73% loss of coverage due to winter injury. All cultivars had recovered to >90% turfgrass coverage by the end of the growing season. Overall, there have been subtle differences in various turf quality parameters among the cultivars, and they all perform similarly in Northwest Arkansas. However, these results also suggest that none of the cultivars have enough cold tolerance to consistently survive winters in our region.

Abbreviations: NTEP, National Turfgrass Evaluation Program

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701
[2] Purdue University, Department of Agronomy, West Lafayette, Ind. 47907

A number of new seashore paspalum (*Paspalum vaginatum*) cultivars have appeared on the market in the past decade as several commercial and academic breeding programs have begun to identify and work with new germplasm. Seashore paspalum has excellent salinity tolerance, color, and mowing quality. Thus, the interest in and use of seashore paspalum has increased in recent years.

The National Turfgrass Evaluation Program (NTEP) is an organization within the U.S. Department of Agriculture that annually oversees turfgrass cultivar evaluation experiments at various sites throughout the U.S. and Canada. Each turfgrass species is tested on a four- to five-year cycle at sites throughout the growing region for that particular species. The University of Arkansas has been an active participant in the NTEP and has conducted several tests on several turfgrass species since 1986. This report will describe the data collected in 2010 for the 2007 NTEP Seashore Paspalum Trial at Fayetteville, Ark.

Materials and Methods

Seven seashore paspalum entries (Table 1) were planted on 9 June 2007 at the University of Arkansas System Division of Agriculture Research and Extension Center in Fayetteville. Plot size was 7 ft by 7 ft and there were three replications of each cultivar. Vegetative cultivars were planted as 2-inch diameter plugs on 12-inch spacings within the plots, while seeded cultivars were broadcast planted at a seeding rate of 1.0 lb/1000 ft^2. Plots were maintained under golf course fairway conditions, with a mowing height of 0.5 inch and monthly applications of 0.5 lb N/1000 ft^2 during the growing season. Irrigation was applied as needed to promote germination and establishment and then to prevent drought stress.

Overall turf quality was evaluated monthly during the growing seasons beginning in October 2007. Quality was visually assessed on a 1 to 9 scale, with 9 representing ideal dark green, uniform, fine-textured turf and 1 representing dead turf. Turfgrass coverage was also monitored periodically throughout the study using digital image analysis (Richardson et al., 2001). Turf genetic color was visually evaluated on a scale of 1 to 9, with 9 representing ideal, dark green turf and 1 representing tan or brown turf. Fall color retention was evaluated on a scale of 1 to 9, with 9 representing turf with green coverage and 1 representing tan or brown turf. Cultivars were visually evaluated for spring green-up using a scale of 1 to 9, with 9 representing complete green color and 1 representing a completely dormant turf stand. Winterkill was monitored in the spring with visual estimates of the percent of the plots that was dead and did not green-up after winter. Density and texture were rated in August on a scale of 1 to 9, with 9 representing maximum density or very fine leaf texture.

Results and Discussion

Because of the extremely low temperatures that were observed during the 2009/2010 winter (Richardson and Karcher, 2011), these plots exhibited up to 98% winterkill in the spring of 2010 (Figs. 1 and 2). There were no differences in winterkill among all cultivars except Salam, which had 73% winterkill and was significantly better than all other cultivars (Fig. 2). Turfgrass coverage of these cultivars following winter injury remained low for much of the growing season and none of the cultivars had reached 100% coverage by July (Table 1). Turfgrass genetic color was darkest green for UGA 31 and UGA 7 and least green for Salam, SRX9HSCP, UGA 22, Seaspray, and Sea Isle 1 (Table 1). However, turfgrass color was considered good for all cultivars. Leaf texture, turfgrass density, and fall color retention was similar among cultivars (Table 1).

There were no differences in turf quality among cultivars in May, June, or July 2010, but there were differences in turf quality among cultivars in August, September and when averaged across the 2010 season (Table 2). On those ratings where differences were significant, turf quality was greatest for UGA 7 and UGA 22 and least for Salam (Table 2). This is noteworthy, as Salam had the greatest winter survival, but rated lower for turf quality than other cultivars. The overall data indicated that there were subtle differences in turf quality among the cultivars and all performed similarly in Northwest Arkansas.

This is the third full season that data have been collected from this trial and there have not been significant differences in performance of these cultivars in Northwest Arkansas. This trial was planted in Fayetteville, Ark. to help better determine the northern adaptation of this turf species as well as to determine if there were differences in winter hardiness among cultivars. Although there was little winterkill in 2008 or 2009, seashore paspalum is not thought to be well adapted to Northwest Arkansas based on previous work with this species in Fayetteville. Additionally, there has not been significant winter damage in Arkansas since 2001 as a significant winterkill event typically occurs only once every ten years. The data obtained from 2010 would suggest that seashore paspalum is not well-adapted to northern Arkansas and the degree of damage observed would also suggest that this species could also experience significant winterkill across much of the state.

Literature Cited

Richardson, M. and D. Karcher. 2012. 2010 Weather Summary for Fayetteville, Arkansas. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:97-98.

Richardson, M.D., D.E. Karcher, and L.C. Purcell. 2001. Quantifying turfgrass cover using digital image analysis. Crop Science 41:1884-1888.

Fig. 1. Winterkill observed on the 2007 NTEP Seashore Paspalum trial. Photo taken on 21 April 2010.

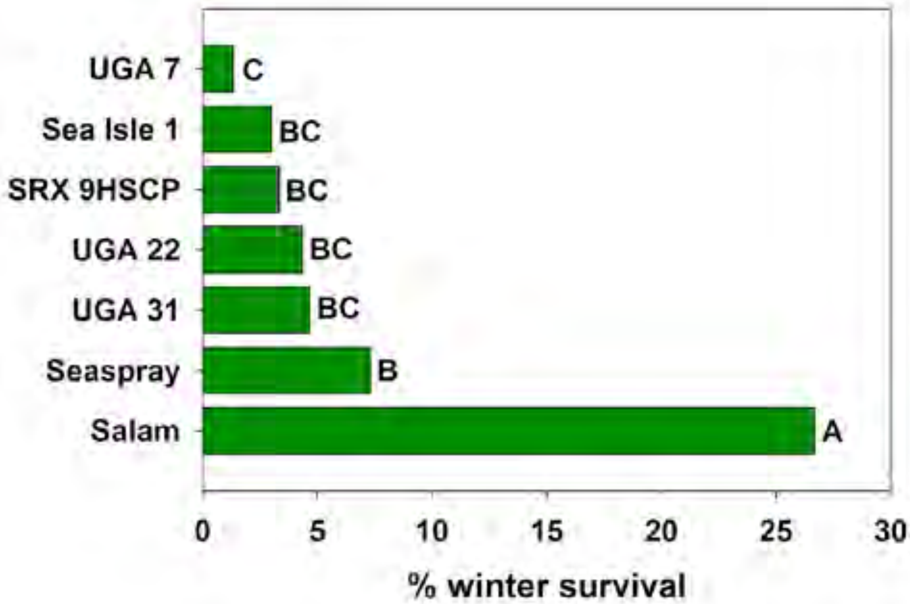


Fig. 2. Winter survival of several seashore paspalum cultivars in the 2007 NTEP Seashore Paspalum Trial at Fayetteville Ark. Data collected on 21 April 2010.

Table 1. Seashore paspalum color, spring green-up, texture, density, fall color, and coverage for various cultivars in Fayetteville, Ark. in 2010.

						Turfgrass coverage[f]	
Entry	**Color[a]**	**Green-up[b]**	**Texture[c]**	**Density[d]**	**Fall color[e]**	**June**	**July**
						----- % coverage -------	
Salam	7.0	6.0	7.0	6.3	6.0	58.3	88.3
SeaIsle1 [g]	7.0	5.3	8.0	7.3	5.7	25.0	65.0
SRX9HSCP [g]	7.0	5.0	7.3	7.0	5.7	36.7	71.7
UGA22	7.0	6.0	7.7	7.0	6.7	38.3	70.0
UGA31	8.0	5.0	7.7	7.3	6.7	48.3	75.0
UGA7	8.0	5.0	8.0	8.0	6.7	23.3	61.7
LSD (0.05)	0.5	0.4	ns	ns	ns	20.7	ns

[a] Turf genetic color was visually evaluated on a scale of 1 to 9, with 9 representing ideal, dark green turf and 1 representing tan or brown turf.
[b] Spring green-up was visually evaluated using a scale of 1 to 9, with 9 representing complete green color and 1 representing a completely dormant turf stand.
[c] Turfgrass texture was visually evaluated on a scale of 1 to 9, with 9 representing very fine leaf texture and 1 representing very coarse texture.
[d] Density was rated on a scale of 1 to 9, with 9 representing maximum density.
[e] Fall color retention was rated on a scale of 1 to 9, with 9 representing maximum green cover.
[f] Turfgrass coverage was measured using digital image analysis.
[g] Seeded seashore paspalum cultivar.

Table 2. Seashore paspalum turf quality ratings in 2010 for various cultivars in Fayetteville, Ark.

Entry	May	June	July	Aug	Sep	Avg.
	---------------------- turfgrass quality[a]					------------------------------
Salam	5.0	5.7	6.7	6.7	6.7	6.1
SeaIsle1[b]	6.0	5.7	6.7	7.3	7.0	6.4
SRX9HSCP[b]	5.3	6.3	7.0	7.0	7.7	6.5
UGA22	5.7	6.0	7.7	8.0	8.0	7.0
UGA7	6.0	6.3	7.3	8.0	8.0	7.1
UGA31	5.3	5.7	7.0	7.3	7.7	6.6
LSD (0.05)	ns	ns	ns	1.2	0.7	0.8

[a] Turf quality was visually evaluated on a scale of 1 to 9, with 9 representing ideal quality and 1 representing dead turf.
[b] Seeded seashore paspalum cultivar.

Winterkill in the 2007 Arkansas Zoysiagrass Trial

Mike Richardson[1], Doug Karcher[1], and Aaron Patton[2]

Additional index words: *Zoysia japonica, Zoysia matrella,* Manilagrass, Japanese lawngrass, turfgrass, cultivars, winter survival

Richardson, M., D. Karcher, and A. Patton. 2012. Winterkill in the 2007 Arkansas Zoysiagrass Trial. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:26-29.

Photo by Mike Richardson

Varying degrees of winter injury on zoysiagrass cultivars.

Summary. Zoysiagrass has become an increasingly popular turfgrass for golf courses and home lawns in Arkansas due to its excellent turfgrass quality, persistence under adverse conditions, and lower maintenance requirements. A zoysiagrass cultivar trial, containing twenty entries, was planted in the summer of 2007 at Fayetteville, Ark. and maintained under typical golf course fairway conditions. The winter of 2009/2010 was one of the more severe on record at Fayetteville and winter injury was observed on many turfgrass trials, including the current zoysiagrass trial. The most severe winter injury was observed on *Zoysia matrella* cultivars, with significant winterkill observed on Shadowturf, DALZ 0701, Pristine Flora, Diamond, DALZ 0501, and DALZ 0702. The *Zoysia japonica* cultivars in this trial had excellent winter survival, and there were only marginal differences between those cultivars. It should be noted that some commonly used *Z. matrella* cultivars also had good winter survival, including Emerald, Zorro, and Cavalier. Results from this study are intended to help residents of Arkansas make informed decisions when selecting turfgrass cultivars. Planting well-adapted cultivars will improve long-term turfgrass quality and reduce reestablishment costs from winterkill or drought and ultimately increase sustainability.

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701
[2] Purdue University, Department of Agronomy, West Lafayette, Ind. 47907

Zoysiagrass (*Zoysia japonica* and *Zoysia matrella*) has become an increasingly popular turfgrass for golf courses and home lawns in the transition zone due to its excellent turfgrass quality, persistence under adverse conditions, and relatively low maintenance requirements. Currently, approximately 13% of lawns in Arkansas are zoysiagrass (Patton, 2009). The popularity of the species is due to its enhanced cold tolerance compared to other warm-season grasses like bermudagrass and St. Augustine, slow growth rate, and competitiveness against weeds. Until recently, most of the zoysiagrass used in the United States and Arkansas has been the cultivar Meyer (sometimes referred to as Meyers or Z-52), which was first introduced in the 1950s. However, in the past twenty years, new germplasm has been collected and released and is starting to be used more frequently in the turfgrass industry.

An integral part of the turfgrass research program at the University of Arkansas is the testing of new and improved turfgrass cultivars for adaptation to this geographic region. Arkansas was not chosen as an official location for the 2007 Zoysiagrass Trial with the National Turfgrass Evaluation Program, so researchers at the University of Arkansas obtained plant material of cultivars commonly used in Arkansas, other commercially available cultivars, and some experimental cultivars from Texas A&M University to evaluate the adaptability of these cultivars in Arkansas. The following report summarizes winter injury that was observed in the spring of 2010 from our 2007 Arkansas zoysiagrass cultivar evaluation trial at Fayetteville, Ark.

Materials and Methods

Twenty zoysiagrass entries were planted on 7 August 2007 at the University of Arkansas System Division of Agriculture Research and Extension Center in Fayetteville. Plot size was 5 ft by 5 ft with three replications of each cultivar. Vegetative cultivars were planted as 2-inch diameter plugs on a 12-inch spacing within the plots, while seeded cultivars were broadcast planted at a seeding rate of 1.0 lb/1000 ft^2. Plots were maintained under typical golf course fairway conditions, with a mowing height of 0.5 inch and monthly applications of 0.5 lb N/1000 ft^2 during the growing season. Irrigation was applied as needed to prevent moderate drought stress.

Although this trial was routinely rated for other turfgrass performance parameters such as quality, color, and texture, this report will only discuss winter injury that was observed in the spring of 2010. Winterkill was measured as percentage turfgrass recovery using digital image analysis methods (Richardson et al., 2001).

Results and Discussion

The majority of zoysiagrass cultivar evaluation trials, including the National Turfgrass Evaluation Program, include both *Zoysia matrella* (Manilagrass or zoysiagrass) and *Z. japonica* (Japanese lawngrass or zoysiagrass) cultivars. *Z. matrella* has a distinct visual appearance mainly due to the narrower leaf blades compared to *Z. japonica*. It has also been established in previous trials that *Z. japonica* cultivars generally have better cold tolerance than *Z. matrella* types (Patton and Reicher, 2007).

One of the main reasons this trial was planted in Fayetteville, Ark. was to determine if there were differences in winter hardiness among zoysiagrass cultivars. Air temperatures at the end of 2009 (Richardson and Stiegler, 2010) and the first two months of 2010 (Richardson and Karcher, 2011) were as much as 6 °F below normal for our location, and we experienced actual low temperatures of 1 °F in Fayetteville. Although there was minimal winterkill in this trial in 2009 (Patton et al., 2010), some cultivars are not thought to be well-adapted to Northwest Arkansas based on previous research in Fayetteville.

Several cultivars experienced significant winterkill during the 2009/2010 winter (Fig. 1), with cultivars such as Shadowturf, a *Z. matrella*, having less than 5% survival following the winter (Fig. 2). Other *Z. matrella* cultivars such as Pristine Flora and Diamond, and the experimental lines DALZ 0701, DALZ 0501 and DALZ 0702, also experienced between 70 and 90% winterkill during this growing season (Fig. 2). Of the cultivars with the most winterkill, Diamond is the only cultivar that is currently sold in Arkansas (Patton et al., 2008). When winter survival data were analyzed by species, the *Z. matrella* cultivars had significantly less survival (43%) compared to the *Z. japonica* cultivars (90%) (data not shown), which supports earlier findings (Patton and Reicher, 2007).

The *Z. japonica* cultivars all had good winter survival, but both Crowne and Victoria had less survival than Meyer or Compadre (Fig. 2), cultivars that are known to possess excellent cold tolerance (Patton and Reicher, 2007). All other *Z. japonica* cultivars had greater than 88% survival and were not statistically different from each other. It was also observed that three *Z. matrella* cultivars, Emerald, Cavalier, and Zorro, had excellent winter survival in this trial and were not statistically different from the top cultivars in the trial (Fig. 2). These data suggest that *Z. matrella* types can be used across the entire state, but users must be aware that some *Z. matrella* types may not possess adequate cold tolerance to persist through our winters.

Summary

In the early 1990s, Meyer was the main zoysiagrass cultivar being grown in Arkansas. Although Meyer is still produced at 25 sod farms in Arkansas (Patton et al., 2008), there are now several newer cultivars being grown in Arkansas, including Crowne, Diamond, Empire, El Toro, Himeno, Matrella (FC13521), Palisades, and Zorro. Some of these cultivars have improved characteristics or turf quality over Meyer, but Meyer remains among the top performing *Z. japonica* cultivars in Arkansas and the transition zone. Although there are differences in winter survival of zoysiagrass cultivars, most of the cultivars produced in Arkansas are able to survive difficult winters in our state. Results from this study are intended to help residents of Arkansas make informed decisions when selecting turfgrass cultivars. Planting well-adapted cultivars will improve turfgrass quality, and reduce reestablishment costs from winterkill or drought and ultimately increase sustainability.

Literature Cited

Patton, A.J. 2009. Arkansas turfgrass acreage. Arkansas Turfgrass Report 2009, Ark. Ag. Exp. Stn. Res. Ser. 579:160-164.

Patton, A.J., and Z. J. Reicher. 2007. Zoysiagrass species and genotypes differ in their winter injury and freeze tolerance. Crop Sci. 47:1619-1627.

Patton, A.J., J.M. Trappe, and J. Boyd. 2008. 2008 Arkansas turfgrass sod source directory. Univ. of Arkansas Cooperative Extension Publication FSA-6136.

Richardson, M.D., D.E. Karcher, and L.C. Purcell. 2001. Quantifying turfgrass cover using digital image analysis. Crop Sci. 41:1884-1888.

Richardson, M., and C. Stiegler. 2010. 2009 weather summary for Fayetteville, Arkansas. Arkansas Turfgrass Report 2009, Ark. Ag. Exp. Stn. Res. Ser. 579:169-170.

Richardson, M., and D. Karcher. 2012. 2010 Weather Summary for Fayetteville, Arkansas. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:97-98.

Fig. 1. Winterkill observed on a zoysiagrass cultivar trial in Fayetteville, Ark. Plots with noticeable winterkill (brown), are primarily *Z. matrella* cultivars. Photo taken 21 April 2010.

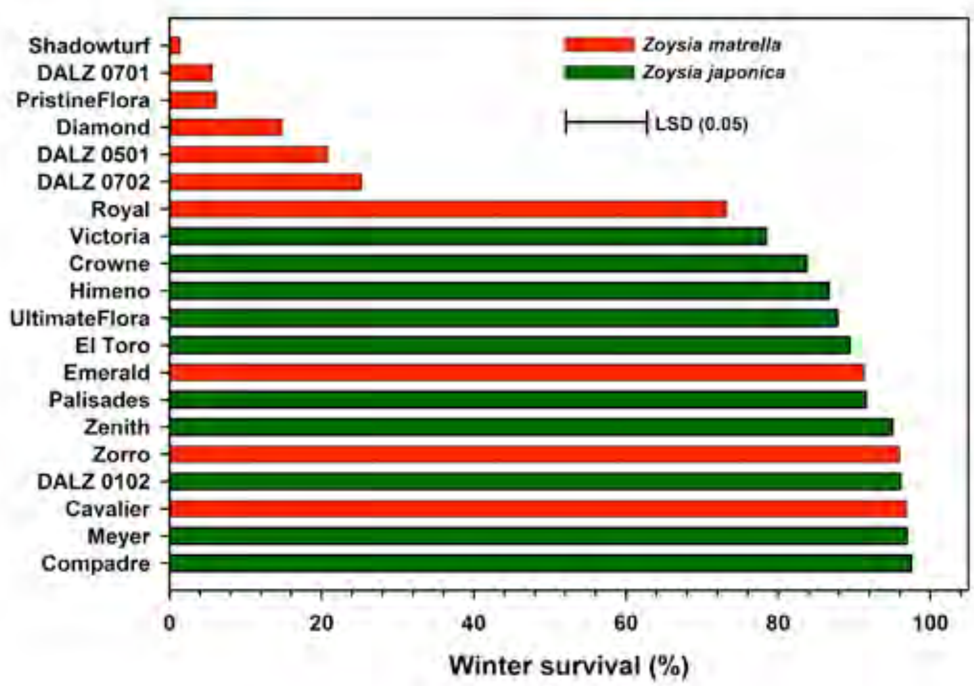


Fig. 2. Winter survival of 20 zoysiagrass cultivars grown at Fayetteville, Ark.

Ball Lie of Creeping and Colonial Bentgrass Cultivars under Fairway Conditions – Year 2 Data

Dan Strunk[1], Joey Young[1], Doug Karcher[1], and Mike Richardson[1]

Additional index words: *Agrostis stolonifera, Agrostis capillaries,* digital image analysis, mowing

Strunk, D., J. Young, D. Karcher, and M. Richardson. 2012. Ball Lie of Creeping and Colonial Bentgrass Cultivars under Fairway Conditions – Year 2 Data. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:30-34.

Photo by Dan Strunk

Digital images are taken of golf balls in the canopy to determine the amount of golf ball exposed.

Summary. The position of a golf ball in the canopy of turf, or ball lie, can have a significant effect on a golf shot. As turf breeders develop improved cultivars for use on golf course fairways and tees, the National Turfgrass Evaluation Program oversees the testing of these improved cultivars in differing climatic regions throughout North America. The University of Arkansas was selected as a test site for the 2008 bentgrass fairway/tee trial which included 27 bentgrass cultivars (colonial or creeping bentgrass). Ball lie was measured on 24, 25, and 26 of October in 2010. Plots were maintained at a 0.5 inch height of cut and data were collected at zero, one, and two days after mowing. Average ball lie was affected by bentgrass cultivar on each day of evaluation. Ball lie was better directly after mowing than after one and two days of growth, although two days of growth had better ball lie than one day. Significance was noted when bentgrass cultivars were averaged over the three testing days with 007, A08-TDN2, and MVS-Ap-101 ranking in the top statistical group. Creeping bentgrass cultivars, on average, had 1.7% more ball exposed than colonial bentgrasses.

Abbreviations: NTEP, National Turfgrass Evaluation Program

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Fairways are an integral part of a golf course and serve as a reward to an accurately placed golf shot. Following a stroke into a fairway, a ball should sit high in the turf giving the golfer the most control on the subsequent shot. This position in the canopy, or ball lie, can have a significant effect on the golfer's ability to accurately hit controlled shots, and is dependent on a variety of factors such as mowing height, uniformity, and shoot density (Cella and Voigt, 2001). Poor ball lie is associated with an increased probability of an errant shot. There are several turf species available that produce adequate shoot density and tolerate close mowing for use in fairways (Morris, 2008). Among these species are numerous cultivars with differing growth characteristics. It is important to understand the variability of ball lie among cultivars of the same species for proper selection of cultivars that are better suited for optimal playing conditions.

In 2001, researchers at the University of Illinois developed a tool, the Lie-N-Eye, which was capable of measuring ball lie in a turf canopy at a height range of 0.6 to 1.0 inch (Cella and Voigt, 2001). The Lie-N-Eye uses a platform, which is set on top of a mown canopy, and an adjustable digital caliper to measure the distance between the top of the ball and the turf canopy. Cell and co-workers also developed the Lie-N-Eye II in 2004 to measure ball lie on turf mown at 0.5 inch (Cella et al., 2004). However, with recent application of digital image analysis in agriculture, and more specifically turf, the University of Arkansas constructed a tool utilizing a digital camera mounted on a platform to measure ball lie (Richardson et al., 2010). Adjustable legs on the platform allow for precise positioning of the camera at a variety of mowing heights. Digital images are taken of a golf ball sitting in the canopy, and then analyzed to determine the total number of pixels of the golf ball in the treated image as compared to the total number of pixels possible of a completely visible golf ball to determine the ball lie of the turf.

The National Turfgrass Evaluation Program (NTEP), a part of the U.S. Department of Agriculture, conducts turfgrass cultivar evaluations at numerous sites throughout North America. In 2008, the University of Arkansas was selected as a test site for a bentgrass fairway/tee trial. There were 23 cultivars officially included in the trial along with four additional cultivars selected due to common use in Arkansas or performance in previous trials (Summerford et al., 2009). The objective of this research was to evaluate ball lie and the change of ball lie over time following a mowing event of 20 cultivars of creeping bentgrass (*Agrostis stolonifera*) and seven cultivars of colonial bentgrass (*Agrostis capillaries*) included in the 2008 NTEP bentgrass fairway/tee trial in Fayetteville, Ark.

Materials and Methods

The evaluation of ball lie was conducted at the University of Arkansas Research and Extension Center in Fayetteville in October 2010 on 27 cultivars of bentgrass (Table 1). The experimental area was established on a native silt loam soil on 1 October 2008, and contained three replicates of each cultivar in a randomized complete block design. The experimental area was maintained under typical fairway conditions with a height of cut at 0.5 inch (Table 2).

Three balls were rolled onto each plot using a ramp that consistently released the ball at a similar height and speed. Ball lie was then measured using a device developed by the University of Arkansas (Richardson et al., 2010). The device, which is comprised of a digital camera mounted on a platform, was used to take digital images of the golf balls. A midpoint wire on the device prevented changing the focal length between images. Images were captured using an Olympus Sp-510UZ digital camera (Olympus Corporation, Center Valley, Pa.). The digital camera was set with an exposure time of 1/250 s and an aperture of F4.5. Analysis of digital images using SigmaScan Pro (v5.0, SPSS, Chicago, Ill.) determined the percentage of total golf ball visible above the turf canopy. Ball lie was measured on 24, 25, and 26 October 2010, corresponding to zero, one, and two days after mowing, respectively.

Results and Discussion

There were differences in average ball lie at zero, one, and two days after mowing when averaged across cultivars (Table 3). Average ball lie decreased 5.2% after one day of growth, but then increased from 88.3% after one day of growth by 1.8% after two days, which contradicts results from 2009 (Strunk et al., 2010). The increase in percent of ball exposed was speculated to be caused by excessive growth during the period of measurement. After one day of growth, the turf leaves were upright, blocking the exposure of the golf ball, but after two days of growth, the turf leaves were long enough to lay over, leaving more ball exposed.

When ball lie was averaged over the three testing dates for each cultivar, significance was found, but unlike the results in 2009, only three cultivars ranked in the highest statistical group (Table 4). The creeping bentgrass cultivars, 007, A08-TDN2, and MVS-Ap-101 had the most ball exposed. Only A08-TDN2 and MVS-Ap-101 were in the highest statistical group in 2009 (Strunk et al., 2010). When colonial and bentgrass cultivars were contrasted, creeping bentgrass cultivars had 1.7% more golf ball exposed on average than the colonial bentgrass cultivars ($P < 0.0001$). Lower ball lie ratings for the colonial bentgrass cultivars, as compared to creeping bentgrass, may have resulted from the more open canopy and upright growth characteristics inherent to colonial bentgrass. No significant interactions were found between days after mowing and bentgrass cultivar.

In summary, creeping bentgrass is a better choice for fairway turf than colonial bentgrass based upon ball lie. In this study, the contrast demonstrated that creeping bentgrass out-performed the colonial bentgrass cultivars. Although overall quality and stress resistance may be more important when selecting a cultivar for golf course fairway or tee use, ball lie should be considered and may aid in the differentiation of cultivars with similar quality and resistance.

Literature Cited

Cella, L., T.B. Voigt, and T.W. Fermanian. 2004. Measuring ball lie on golf course fairways. Crop Sci. 44:214-217.

Cella, L. and T. Voigt. 2001. The perfect lie: studying the lie of a golf ball on fairway turf with a Lie-N-Eye. USGA Green Sec. Rec. 39(6):57.

Morris, K.N. 2008. 2003 National bentgrass (fairway/tee) test. 2004-07 Data. Final Report NTEP no. 08-7.

Richardson, M.D., D.E. Karcher, A.J. Patton, and J.H. McCalla. 2010. Measurement of golf ball lie in various turfgrasses using digital image analysis. Crop Sci. 50:730-736.

Strunk, D., J. Young, D. Karcher, M. Richardson, and A. Patton. 2010. Ball lie of creeping and colonial bentgrass cultivars under fairway conditions. Arkansas Turfgrass Report 2009, Ark. Ag. Exp. Stn. Res. Ser. 579:40-45.

Summerford, J., D. Karcher, M. Richardson, and A. Patton. 2009. Summary of 2008 NTEP bentgrass fairway/tee trial-establishment. Arkansas Turfgrass Report 2008, Ark. Ag. Exp. Stn. Res. Ser. 568:127-131.

Table 1. Bentgrass cultivars in the 2008 NTEP bentgrass fairway/tee trial in Fayetteville, Ark.

Entry	Species	Entry	Species
Penncross	Creeping	SRP-1WM[b]	Creeping
007	Creeping	T-1	Creeping
CY-2	Creeping	BCD	Colonial
LTP-FEC	Creeping	Benchmark DSR	Creeping
PennlinksII/PenneagleII[a]	Creeping	Declaration	Creeping
Princeville	Creeping	MVS-Ap-101[b]	Creeping
A08-EBM[b]	Colonial	Tyee[a]	Creeping
A08-TDN2[b]	Creeping	A08-FT12[b]	Colonial
Authority	Creeping	HTM	Creeping
L-93	Creeping	PST-R9D7[b]	Colonial
Memorial	Creeping	Tiger II	Colonial
Crystal Bluelinks	Creeping	Alister[a]	Colonial
PST-OJD[b]	Creeping	Greentime	Colonial
SR-1020[a]	Creeping		

[a] Not an official entry of the 2008 NTEP bentgrass trial but included as an Arkansas standard.
[b] Entry is experimental and at this time not commercially available.

Table 2. Management of plots in the 2008 NTEP Bentgrass fairway/tee trial.

Management	Description
Mowing	Three times/week at 0.5 inch with a Toro 3100 (Toro Company, Bloomington, Minn.)
Fertility	0.5 lbs Nitrogen/1000 ft^2 per month during active growth
Irrigation	As needed to prevent drought stress
Cultivation	Aerification (0.5 in. x 1.5 in.)
Sand topdressing	As needed to smooth plots
Wetting agents	None
Plant growth regulators	Primo Maxx (trinexipac-ethyl) at 6 oz/acre
Pesticides	Applied as needed for curative purposes

Table 3. Average ball lie at 0, 1, and 2 days after mowing, averaged across cultivars, in October 2010 on the 2008 NTEP bentgrass fairway/tee trial in Fayetteville, Ark.

Days after mowing[a]	Measurement date	Average ball lie
		--------(%)--------
0	24 October	93.5 A[b]
1	25 October	88.3 C
2	26 October	90.1 B

[a] Plots were mown with a Toro 3100 at 0.5 inch.
[b] Means followed by the same letter do not differ significantly at $\alpha = 0.05$.

Table 4. Ball lie of colonial and creeping bentgrass cultivars in the 2008 NTEP bentgrass fairway/tee trial in Fayetteville, Ark. Measurements were averaged across 0, 1, and 2 days after mowing in October 2010.

Entry	Species	Average Ball Lie	
		----------(%)----------	
007	Creeping	91.9	A[a]
A08-TDN2[c]	Creeping	91.8	A
MVS-Ap-101[c]	Creeping	91.7	A
Tyee[b]	Creeping	91.6	AB
Crystal Bluelinks	Creeping	91.5	AB
SR-1020[b]	Creeping	91.2	AB
PennlinksII/Penneagle II[b]	Creeping	91.1	AB
HTM	Creeping	91.0	ABC
Pencross	Creeping	90.9	ABC
Benchmark DSR	Creeping	90.9	ABC
T-1	Creeping	90.8	ABC
Memorial	Creeping	90.6	ABCD
Declaration	Creeping	90.6	ABCD
Princeville	Creeping	90.5	ABCD
Cy-2	Creeping	90.3	ABCD
L-93	Creeping	90.3	ABCDE
PST-OJD[c]	Creeping	90.2	ABCDE
A08-FT12[c]	Colonial	90.1	ABCDE
Authority	Creeping	90.1	ABCDE
Alister[b]	Colonial	90.0	ABCDE
SRP-1WM	Creeping	89.9	ABCDE
Greentime	Colonial	89.7	ABCDE
LTP-FEC	Creeping	89.6	ABCDE
BCD	Colonial	89.3	BCDE
A08-EBM[c]	Colonial	88.6	CDE
TigerII	Colonial	88.4	DE
PST-R9D7[c]	Colonial	88.0	E
$LSD_{(0.05)}$		**2.5**	

[a] Means followed by the same letter do not differ statistically at $\alpha < 0.05$.
[b] Not an official entry of the 2008 NTEP bentgrass trial but included as an Arkansas standard.
[c] Entry is experimental and at this time not commercially available.

Phytotoxicity of Aminoethoxyvinyl-glycine Hydrochloride on Creeping Bentgrass

Dan Strunk[1], Doug Karcher[1], and Mike Richardson[1]

Additional index words: AVG, Amino-ethoxyvinyl-glycine Hydrochloride

Strunk, D., D. Karcher, and M. Richardson. 2012. Phytotoxicity of Amino-ethoxyvinyl-glycine Hydrochloride on Creeping Bentgrass. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:35-38.

Photo by Dan Strunk

Phytotoxicity symptoms caused by applications of amino-ethoxyvinylglycine hydochloride.

Summary. Aminoethoxyvinylglycine hydrochloride (AVG) is a naturally occurring compound from the process of fermentation that inhibits the production of ethylene in plants though reducing enzyme activity within the Yang cycle. In 2009, a study was conducted using AVG to prevent temperature stress related injury and ethylene production on creeping bentgrass grown in a growth chamber, and the results from the study indicated that AVG could be used to prevent injury. However, the study had limited detail on the amount of AVG that could safely be applied to creeping bentgrass, or more importantly, how safe AVG was on creeping bentgrass being maintained as a putting green. Therefore, the objective of this study was to determine maximum application rates for AVG on creeping bentgrass putting greens that did not produce phytotoxicity. The results of this study indicated that higher rates of AVG (>137.6 grams per acre) were phytotoxic at 4, 7, and 14 days after treatment, but symptoms of injury were not present after 21 days. The lower rates (<137.6 grams per acre) did not cause any injury to the turf. When injury ratings were averaged over the entire 28 day evaluation period, AVG application ratings were not significantly different.

Abbreviations: AVG, aminoethoxyvinylglycine hydrochloride

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Aminoethoxyvinylglycine hydrochloride (AVG) is a naturally occurring compound formed as a byproduct of fermentation that blocks the production of ethylene through inhibiting an enzyme in the Yang cycle (Venburg et al., 2008). This compound was shown to effectively reduce ethylene biosynthesis in creeping bentgrass (*Agrostis stolonifera*) subjected to heat stress in a growth chamber (Xu and Huang, 2009). After 21 days in a 35 °C growth chamber, plants treated with AVG had 25% less ethylene produced compared to an untreated control (Xu and Huang, 2009). Assuming the biosynthesis of ethylene in turf can be decreased through the use of AVG, this could help reduce the effects of stress-related ethylene production. However, the tolerance of turf, such as putting green height creeping bentgrass to applications of AVG has not been studied. Therefore, the objective of this study was to evaluate the tolerance of creeping bentgrass to applications of AVG and determine the proper application rate for creeping bentgrass under putting green maintenance procedures.

Materials and Methods

A randomized complete block design with six treatments and five replications was created on an established creeping bentgrass (cv. Penn A-1) putting green at the University of Arkansas Research and Extension Center in Fayetteville, Ark. Five application rates of AVG (ReTain, Valent Biosciences, Walnut Creek, Calif.) and an untreated control were applied using a CO_2 spraying system and a low volume hollow cone nozzle on plots measuring 2.25 ft^2 (Table 1). All applications were made using a spray shield to prevent contamination of neighboring plots and produce consistent applications among treatments. The plots were visually rated for color on a numerical scale (1 = brown; 9 = dark green) at 0, 1, 4, 7, 21, and 28 days after application of AVG to determine if any application rates were phytotoxic to creeping bentgrass maintained as a putting green.

Results and Discussion

When AVG rates were averaged over time, there were no significant differences in turfgrass color among AVG rates or the untreated control. All AVG rates were acceptable on creeping bentgrass over the testing period even though the higher rates caused some injury, but the injury was only evident when treatments were analyzed in relation to time (Table 2). Injury, or loss of turfgrass color, was evident at 4, 7, and 14 days after treatment with turfgrass color averages of 7.07, 7.47, and 7.70, respectively. At 21 days after treatment, all visual color differences were gone. In addition, the interaction between AVG rate and days after treatment was significant. This significant interaction indicated that a detrimental effect on turfgrass color occurred at different days after treatment for particular application rates of AVG. The two highest rates had significant injury on 4, 7 and 14 days after treatment, although the worst injury occurred at 4 and 7 days (Table 3). From the results of this study, AVG can safely be applied to creeping bentgrass putting greens.

Literature Cited

Venburg, G.D., R. Hopkins, J. Retamales, J. Lopez, J.Hansen, G.G Clarkes, M. Shroder, and A.C. Rath. 2008. Recent developments in AVG research. Acta Hort. 796:43-49.

Xu, Y. and B. Huang. 2009. Effects of foliar-applied ethylene inhibitor and synthetic cytokinin on creeping bentgrass to enhance heat tolerance. Crop Sci. 49:1876-1884.

Table 1. Application rates of AVG tested on a creeping bentgrass putting green at the Research and Extension Center of the University of Arkansas.

Treatment	Application Rate
	grams AVG acre^{-1}
1	0
2	45.7
3	91.5
4	137.6
5	228.6
6	457.3

AVG = aminoethoxyvinylglycine hydrochloride.

Table 2. Average turfgrass color for days after treatment with AVG or untreated as the control.

Days After Treatment	Average Color[a]	
	-------1-9 scale-------	
0	8.00	A[b]
1	8.00	A
4	7.07	D
7	7.47	C
14	7.70	B
21	8.00	A
28	8.00	A

[a] Turfgrass color was visually rated on a numerical scale (1 = brown, 9 = dark green).
[b] Means followed by the same letter do not significantly differ at the $\alpha = 0.05$.
AVG = aminoethoxyvinylglycine hydrochloride.

Table 3. Average turfgrass color for the interaction of days after treatment and AVG application rate.

Application Rate	Days After Treatment	Average Color[a]
grams AVG $acre^{-1}$		1-9 scale
0	0	8.0 A[b]
0	1	8.0 A
0	4	8.0 A
0	7	8.0 A
0	14	8.0 A
0	21	8.0 A
0	28	8.0 A
45.7	0	8.0 A
45.7	1	8.0 A
45.7	7	8.0 A
45.7	14	8.0 A
45.7	21	8.0 A
45.7	28	8.0 A
91.5	0	8.0 A
91.5	1	8.0 A
91.5	7	8.0 A
91.5	14	8.0 A
91.5	21	8.0 A
91.5	28	8.0 A
137.6	0	8.0 A
137.6	1	8.0 A
137.6	7	8.0 A
137.6	14	8.0 A
137.6	21	8.0 A
137.6	28	8.0 A
228.6	0	8.0 A
228.6	1	8.0 A
228.6	21	8.0 A
228.6	28	8.0 A
457.3	0	8.0 A
457.3	1	8.0 A
457.3	21	8.0 A
457.3	28	8.0 A
45.7	4	7.8 AB
91.5	4	7.8 AB
137.6	4	7.6 BC
228.6	14	7.4 C
228.6	7	7.0 D
457.3	14	6.8 D
228.6	4	6.4 E
457.3	7	5.8 F
457.3	4	4.8 G

[a] Turfgrass color was visually rated on a numerical scale (1 = brown, 9 = dark green).
[b] Means followed by the same letter do not significantly differ at the $\alpha = 0.05$.
AVG = aminoethoxyvinylglycine hydrochloride.

Shot Quality is Affected by Ball Lie

Dan Strunk[1], Doug Karcher[1], Mike Richardson[1], Aaron Patton[2], and Joey Young[1]

Additional index words: tall fescue, Kentucky bluegrass, creeping bentgrass, carry distance, accuracy, backspin, shot height

Strunk, D., D. Karcher, M. Richardson, A. Patton, and J. Young. 2012. Shot Quality is Affected by Ball Lie. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:39-43.

Photo by Doug Karcher

Dr. Aaron Patton striking ball from Kentucky bluegrass plots.

Summary. With new technology such as golf ball tracking systems, it is now possible to scientifically evaluate the golf swing and the parameters associated with hitting a quality golf shot. The objective of this study was to evaluate the effect of golf ball lie on subsequent shot quality. Two golfers (USGA handicaps 0 and 8) hit golf balls using a seven iron from plots of tall fescue, Kentucky bluegrass, and creeping bentgrass at mowing heights ranging from 0.5 to 4 inches. Balls were dropped from shoulder height to simulate taking a drop, and ball lie was measured before the golf ball was hit. Shot parameters such as carry distance, accuracy, spin rate, and shot height were measured using a golf ball tracking system. From the data, carry distance, backspin, accuracy, and shot height improved as ball lie improved. However, even though the relationship of ball lie and the shot parameters was significant, ball lie is not the only factor that determines the quality of the golf shot.

Abbreviations: USGA, United States Golf Association

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701
[2] Purdue University, Department of Agronomy, West Lafayette, Ind. 47907

The golf industry is constantly working to develop new technology to allow players a more precise way to practice and play. Technologies such as rangefinders and global positioning systems have found their way into golf bags, particularly those of players who are interested in improving their rounds. During practice, ball tracking technology has allowed golfers the ability to know parameters about each shot that are normally impossible to know otherwise. A golfer gets immediate feedback on carry distance, spin rate and direction, ball velocity, and launch angle as well as many other factors.

In 2007, the United States Golf Association (USGA) conducted a study to determine spin rates from U- and V-shaped grooves from different ball lies using golf ball tracking technology. Professional players from a developmental tour hit balls from various ball lies described as light rough (leaf blade length half the height of the ball), medium rough (leaf blade length the full height of the ball), and long rough (leaf blade height twice the height of the ball). From the study, it was evident that the lie of the ball and groove shape affected the spin rate that could be produced (USGA, 2007).

The determination of ball lie in the USGA study was a subjective measurement open to interpretation of how tall the turfgrass leaves were in relation to the ball. Instead of visual determination, it is possible to accurately describe ball lie through the use of digital image analysis (Richardson et al., 2010), allowing for precise measurements of the amount of ball exposed through the turf canopy. With these technological advances, the effects of golf ball lie on the ability of a golfer to hit a golf shot can be accurately determined based on a variety of parameters, not just spin rate. Therefore, the objective of this study was to evaluate the effects of ball lie on golf shots.

Materials and Methods

Blocks of tall fescue (*Festuca arundinacea*), Kentucky bluegrass (*Poa pratensis*), and creeping bentgrass (*Agrostis stolonifera*) were mown at a range of heights typically found on a golf course. Mowing heights for tall fescue ranged from 3.0 to 4.0 inches, while heights for Kentucky bluegrass ranged from 1.0 to 3.5 inches. The creeping bentgrass plots were mown at a height of 0.5 inches with some plots not being mown for three or five days.

Two golfers (USGA handicaps 0 and 8) were selected to hit golf balls from plots in a randomized order. Each species was completed before moving to the next. Golf balls were dropped by each golfer from shoulder height to simulate taking a drop in golf. Digital images used to measure ball lie were taken after the golf ball was dropped and resting in the turf canopy. The golf ball was then hit using a seven iron and the flight of the ball was tracked using a golf ball tracking system (Flightscope Kudu, EDH Ltd., Stellenbosch, South Africa) (Fig. 1). Each golfer hit five golf balls per plot with their own seven iron to determine the effect of ball lie on carry distance, backspin, accuracy, and shot height.

Results and Discussion

Carry Distance. The carry distances of golf shots from both golfers increased as more golf ball was exposed in the turf canopy (Fig. 2). Shorter carry distance is expected when hitting out of poor ball lies as there is more turf leaves between the club and the ball, and the taller turf slows the decent of the club before making contact with the ball. The regression analysis showed that there was a significant relationship between ball lie and carry distance, but the low r^2 values indicated that ball lie does not fully explain the change in carry distance.

Backspin. Golf shots from the deep rough where poor ball lie is likely have been associated with decreased backspin due to amount of turf leaves between the club face and the ball that reduces the impact of the grooves of the club on the ball. From this experiment, reduced backspin from poor ball lie has been confirmed (Fig. 3), but like carry distance, although the relationship was significant, the low r^2 value indicated that other parameters were involved and ball lie alone could not be used to predict spin rate.

Accuracy. The ability of a golfer to hit accurate golf shots was diminished when hitting from a poor ball lie (Fig. 4). As the percent of the golf ball exposed increased, the accuracy of the golf shot increased. However, with the number of factors to the golf swing, ball lie could not serve as a predictor for accuracy of a golf shot which was described by the low r^2 value even though the relationship was significant.

Shot Height. The height of a golf shot determines how soft the golf will land on a putting surface. Lower shots typically bounce harder and are less likely to stop on a putting surface. The results from this experiment showed that shot height increased with better ball lie (Fig. 5). However, similar to carry distance, backspin, and accuracy, ball lie could not be used as a predictor for shot height.

Conclusions

Based on the data from this experiment, the quality of a golf shot was affected by ball lie. However, with the complexity of the golf swing, ball lie could not be used as a sole predictor of shot quality for the two golfers tested. In various ball lies, golfers tend to change approach and swing depending on the height of the turf and depth within the canopy at which the ball is resting in attempt to prevent the effects of ball lie. This process of selective swing parameter changes prevents consistency between shots. The results of this study indicated that a significant relationship does exist between ball lie and shot quality. There is a possibility that the predicting power of ball lie may increase when better golfers are tested, such as those playing on the PGA tour, where ball lie dependent swing changes will remain consistent between shots.

Literature Cited

Richardson, M., D. Karcher, A. Patton, and J. McCalla. 2010. Measurement of golf ball lie in various turfgrasses using digital image analysis. Crop Sci. 50:730-736.

United States Golf Association. 2007. A study of the effect of rough height on tour player performance using U- and V-grooved irons. Retrieved November 10, 2010, from http://www.usga.org/workarea/linkit.aspx

Fig. 1. Coach Adams of the lady Razorbacks golf team operating the Flightscope Kudu as the 0 handicap golfer prepares to strike the golf ball. Ball lie has already been measured.

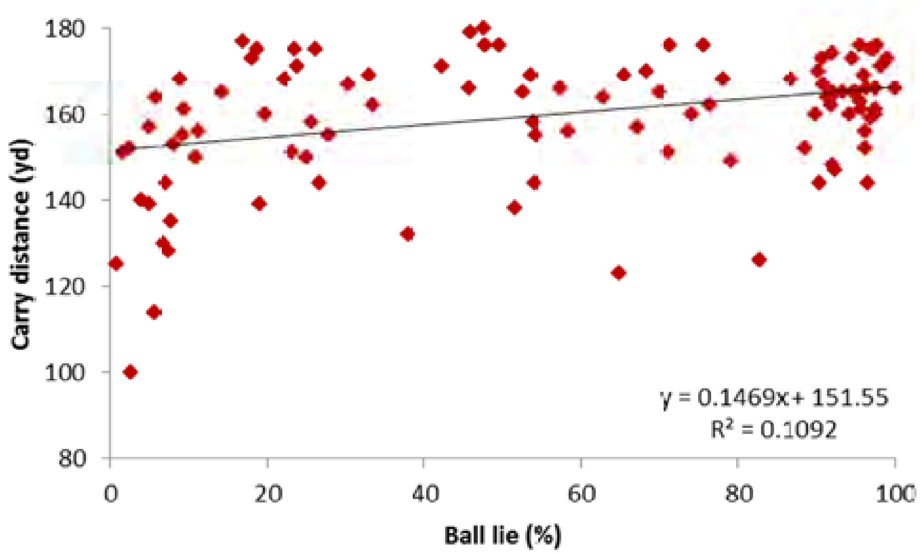


Fig. 2. The effect of ball lie on carry distance of golf shots hit with a seven iron for two golfers (USGA handicaps 0 and 8) from tall fescue, Kentucky bluegrass, and creeping bentgrass over heights ranging from 0.5 to 4.0 in. The relationship between ball lie and carry distance was significant ($p < 0.0001$).

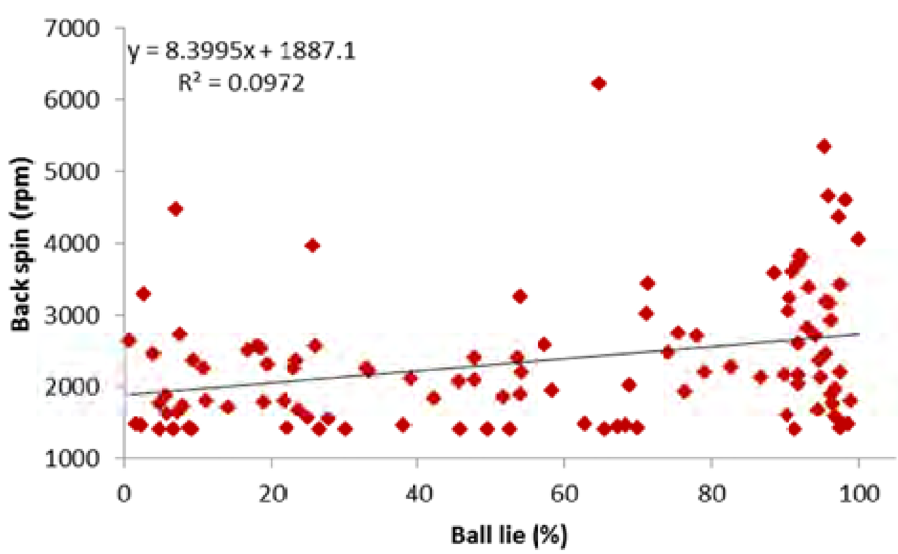


Fig. 3. The effect of ball lie on backspin of golf shots hit with a seven iron for two golfers (USGA handicaps 0 and 8) from tall fescue, Kentucky bluegrass, and creeping bentgrass over heights ranging from 0.5 to 4.0 in. The relationship between ball lie and backspin was significant ($p < 0.001$).

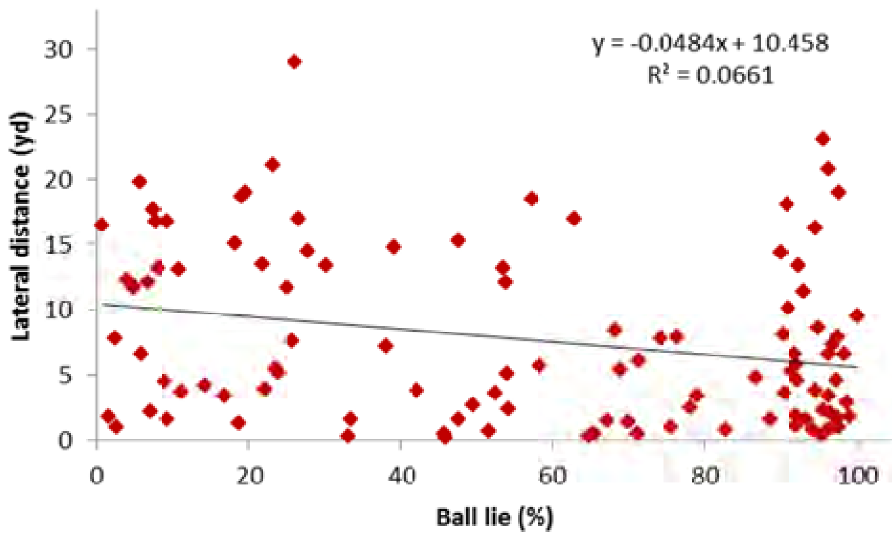


Fig. 4. The effect of ball lie on accuracy (lateral distance) of golf shots hit with a seven iron for two golfers (USGA handicaps 0 and 8) from tall fescue, Kentucky bluegrass, and creeping bentgrass over heights ranging from 0.5 to 4.0 in. The relationship between ball lie and accuracy was significant (*p* = 0.0072).

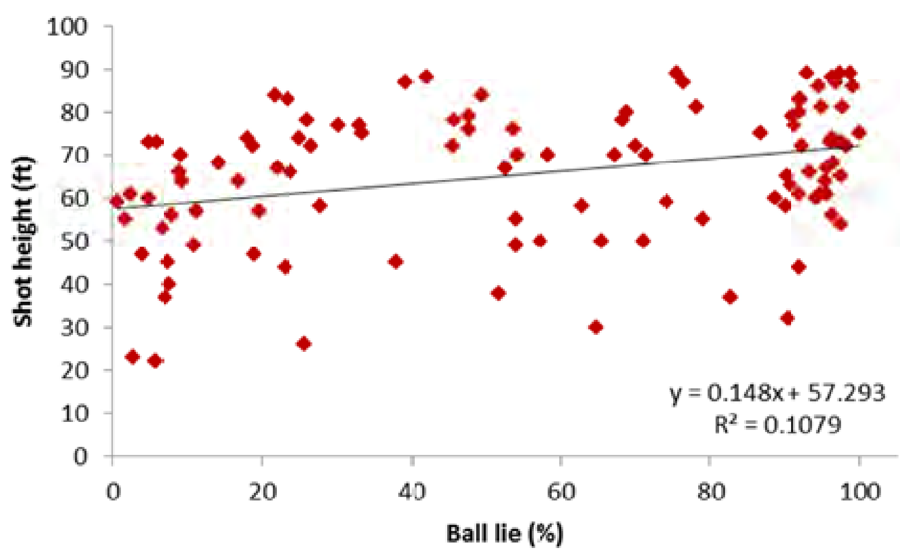


Fig. 5. The effect of ball lie on shot height of golf shots hit with a seven iron for two golfers (USGA handicaps 0 and 8) from tall fescue, Kentucky bluegrass, and creeping bentgrass over heights ranging from 0.5 to 4.0 in. The relationship between ball lie and shot height was significant (*p* < 0.001).

Color Retention of the Synthetic Sports Surface at Donald W. Reynolds Razorback Stadium

Dan Strunk[1], Doug Karcher[1], and Mike Richardson[1]

Additional index words: hue, saturation, brightness, digital image analysis, athletic field, crumb-rubber in-filled, artificial turf, Frank Broyles Field

Strunk, D., D. Karcher, and M. Richardson. 2012. Color Retention of the Synthetic Sports Surface at Donald W. Reynolds Razorback Stadium. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:44-49.

Photo by Mike Richardson

Synthetic turf installed at Don W. Reynolds Stadium at the University of Arkansas.

Summary. As population continues to increase, more and more user groups are requiring athletic playing surfaces to conduct community sports and other events. Natural turfgrass playing surfaces provide many benefits to the environment and are typically considered safer, but lack the ability to withstand extensive traffic. As a remedy, many communities are turning to synthetic, crumb rubber in-filled playing surfaces that can withstand a large number of events. Many studies have looked into player safety associated with synthetic fields and cost analysis of construction and maintenance, but no studies exist evaluating the color retention of the synthetic fibers. Fading and changing of color can be aesthetically displeasing to spectators, players, and coaches. Therefore, the objective of this study was to determine if the color of the synthetic fibers of Frank Broyles Field in Donald W. Reynolds Razorback stadium change over time. Digital images were collected from green, red, black, and white field surfaces in 2009 and 2010 from the same location and analyzed according to methods described in Karcher and Richardson (2002). The green fibers showed the greatest change, and the change was visibly detected. Red, black, and white fibers faded or changed hues, but not to the extent of the green fibers. The color fading and change was likely caused by exposure to UV rays and weather.

Abbreviations: DIA, digital image analysis; UV, ultraviolet

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

With continual population growth and increased community size, the number of athletic events on a given sports field is on the rise. The increased demand for playing space and adequate playing surfaces has aided in the popularity of infilled synthetic fields that can withstand multiple athletic events, practices, and concerts within the same season. While the number of events that can be held on a synthetic field is beneficial, there are a number of problems associated with this athletic field system. Many studies have been conducted on synthetic fields to determine incidence and severity of player injuries, environmental concerns, other health risks including toxicological and bacterial, and construction and maintenance costs, but limited knowledge is available for color retention of the synthetic fibers through the lifespan of the field (Begier et al., 2004; McNitt, 2005). Faded logos and lines can diminish the overall playability of the field and be displeasing to players, coaches, and spectators who take pride in their affiliation to a particular team or school.

The color of an object can be dissected into three main parts: hue, saturation, and brightness. Hue describes the wavelength of the reflected light from the surface of an object and allows for the determination of chromatic colors such as red, green, blue, and yellow (Judd, 1940) and can be quantified as an angle on a circular scale (Adobe Systems, 2002). Saturation is the dominance of a particular hue (purity) within a given color or the difference of a chromatic color from an achromatic color such as gray (Judd, 1940) and ranges from 0 (gray) to 100% chromatic color (Photoshop V. 7.0, Adobe Systems, San Jose, Calif.). Brightness describes how light or dark a color is perceived determined by the class of grays it most closely resembles (Judd, 1940) represented as 0 as black and 100% as white. Hue, saturation, and brightness of turf surfaces can be determined through digital image analysis (DIA) (Karcher and Richardson, 2002). The objective of this study was to determine if the color of the synthetic turf installed at Reynolds Razorback Stadium changes over time and, if so, determine the rate at which the color changes.

Materials and Methods

In the summer of 2009, the Frank Broyles field at the Donald W. Reynolds Stadium at the University of Arkansas (Fayetteville, Ark.) was renovated to replace the natural turfgrass playing surface with Sportexe PowerBlade HP 2.5 synthetic turf (Shaw Sportexe, Berkshire Hathaway Company, Kennesaw, Ga.) with a infill mix of sand and rubber (50% wt.). High quality digital images were collected in Sept 2009 and Dec 2010 from green, red, black, and white sections of the field (Fig. 1) using an Olympus SP-510UZ digital camera (Olympus Corporation, Center Valley, Pa.). The camera was mounted in a light box to prevent ambient light from altering the quality of the digital images and produce consistent lighting for all images. Analysis of the pictures (Karcher and Richardson, 2002) produced values for hue, saturation, and brightness and defined the colors in red, green, and blue. The initial analysis calculated color by including the synthetic fibers and the crumb rubber which determined the color of the turf as it appears to a spectator. A separate analysis was performed on the synthetic fibers only by excluding any pixels that were in the lower 10% of the brightness scale (black and dark grays).

Results and Discussion

As would be expected from exposure to continuous sunlight and weather, the synthetic fibers on Frank Broyles field are changing colors (Table 1). The red synthetic fibers such as those in the razorback mid-field logo and end zone lettering showed significant changes which indicated that the red color is fading with a decrease in saturation and an increase in brightness. Both analyses, with and without pixels containing black and dark grays, were indicative of the fading. And, although the changes may not be easily seen with the human eye, if the fading continues, the color change will likely be visible in a couple of years (Fig. 2).

The green synthetic fibers which comprise the majority of the field had significant color change. There was approximately a 25 degree increase in hue meaning the green color is turning to a more blue-green color (Fig. 3). In addition to the change in hue, saturation of the green has decreased while brightness has increased which is indicative of fading color (becoming lighter and more gray).

The black and white synthetic fibers have changed colors as well, although the changes in hue of both colors have minimal effects on color perception. Saturation and brightness is more important for black and white as black represents colors fully saturated with a lack of brightness while white has minimal saturation and high brightness. However, with few observations, it was not possible to determine if significant differences were present.

Conclusions

The results from this study indicate that the synthetic fibers on Frank Broyles field at Donald W. Reynolds Stadium changed color from 2009 to 2010. After a year of exposure to the sun and weather, red, green, black, and white fibers have faded or changed hue. Ultraviolet radiation from the sun has been known to break down many synthetic materials such as PVC and Kevlar, and caused color fading in textiles. Even though Frank Broyles field is being properly maintained, the color of the fibers will probably continue to change over the years to come.

Literature Cited

Begier, E.M., K. Frenette, N. Barrett, P. Mshar, S. Petit, D.J. Boxrud, K. Watkins-Colwell, S. Wheeler, E.A. Cebelinski, A. Glennen, D. Nguyen, and J.L. Hadler. 2004. A high-morbidity outbreak of methicillin-resistant Staphylococcus aureus among players on a college football team, facilitated by cosmetic body shaving and turf burns. Clin Infect Dis. 39:1446-1453.

Judd, D.B. 1940. Hue, saturation, and lightness of surface colors with chromatic illumination. JOSA. 30(1):2-32.

Karcher, D.E. and M.D. Richardson. 2002. Quantifying turfgrass color using digital image analysis. Crop Sci. 43:943-951.

McNitt, A.S. 2005. Synthetic turf in the USA – trends and issues. Int. Turfgrass Soc. Res. J. 10:27-33.

Table 1. Average hue, saturation, and brightness of digital images collected in September 2009 and December 2010 of Frank Broyles field. Analysis was conducted with the inclusion and exclusion of pixels of the lower 10% of the brightness scale, which represents blacks and dark grays such as crumb rubber.

	Without Exclusion Threshold								
	2009 Averages			2010 Averages			Difference (2010-2009)		
Turf Color	Hue	Saturation	Brightness	Hue	Saturation	Brightness	ΔHue[a]	ΔSaturation	ΔBrightness
Black	134.26	0.20	0.04	195.19	0.27	0.11	60.94[b]	0.08[b]	0.07[b]
Green	90.03	0.58	0.16	111.90	0.47	0.29	21.87 ± 1.50[c]	-0.12 ± 0.04	0.13 ± 0.04
Red	1.68	0.82	0.25	1.07	0.73	0.33	-0.61 ± 0.28	-0.09 ± 0.03	0.08 ± 0.02
White	172.37	0.04	0.62	189.91	0.15	0.71	17.54[b]	0.11[b]	0.09[b]
	With Exclusion Threshold								
	2009 Averages			2010 Averages			Difference (2010-2009)		
Turf Color	Hue	Saturation	Brightness	Hue	Saturation	Brightness	ΔHue	ΔSaturation	ΔBrightness
Black	142.92	0.05	0.16	197.11	0.21	0.18	54.20[b]	0.16[b]	0.02[b]
Green	86.33	0.54	0.25	111.30	0.44	0.33	24.97 ± 1.67	-0.10 ± 0.03	0.08 ± 0.02
Red	0.39	0.79	0.38	0.59	0.70	0.39	0.20 ± 0.24	-0.09 ± 0.02	0.02 ± 0.01
White	173.37	0.04	0.64	189.99	0.15	0.71	16.62[b]	0.11[b]	0.07[b]

[a] ΔHue is read as the change in hue.
[b] The number of observations was limited for white and black fibers so no confidence intervals could be computed.
[c] Confidence intervals were calculated at $\alpha = 0.05$.

Fig. 1. Map of image location of digital images taken of Frank Broyles field inside of Donald W. Reynolds Razorback stadium. Picture courtesy of M. Richardson.

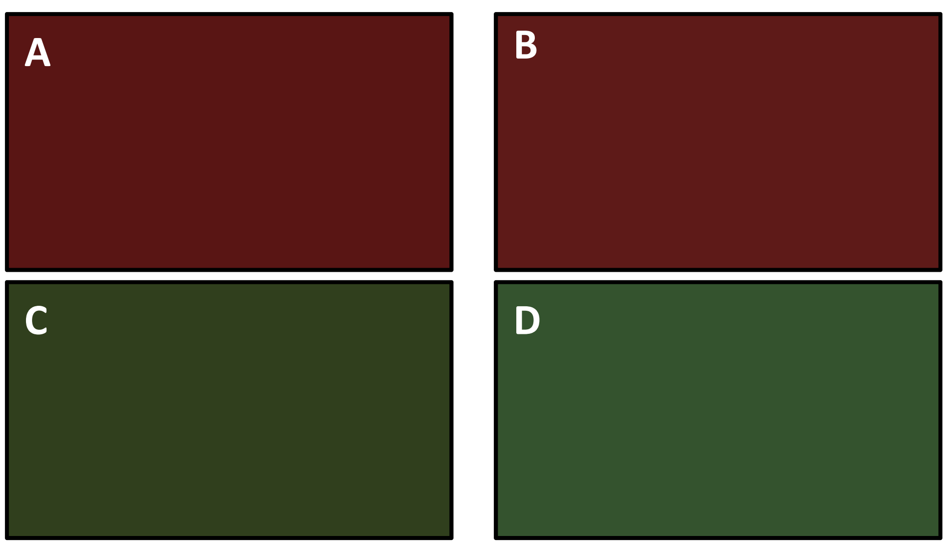


Fig. 2. The color of the synthetic fibers of Frank Broyles field determined through digital image analysis. Boxes A and C represent the color of the fibers in 2009, and boxes B and D are the color of fibers in 2010.

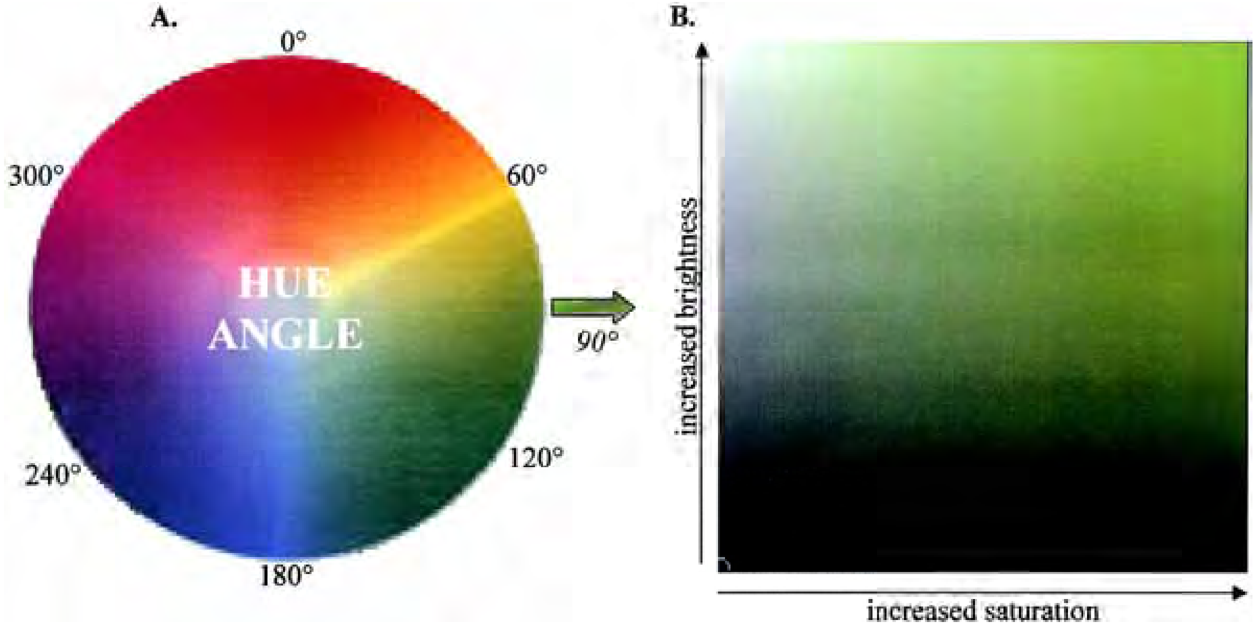


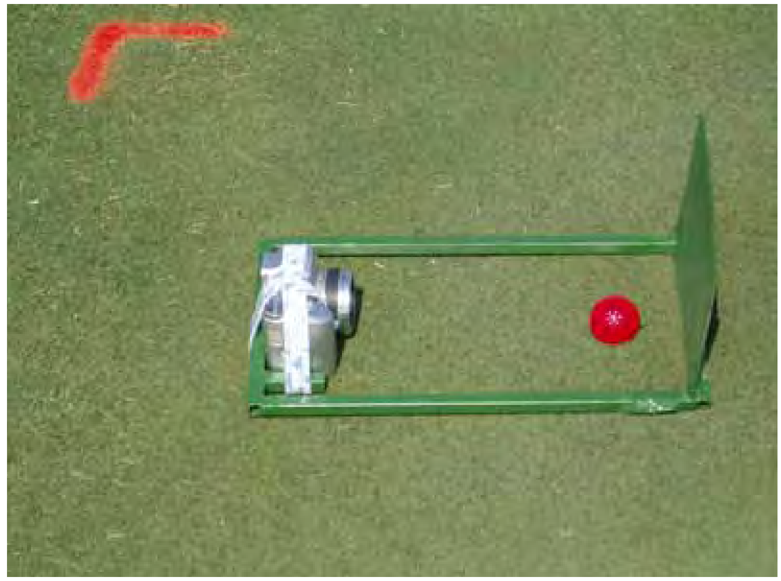
Fig. 3. The color wheel representing the angles associated with particular colors (A) and a graph depicting the relationship between brightness and saturation (B).

Evaluating Ball Mark Severity and Recovery Using Digital Image Analysis

Joseph Young[1], Mike Richardson[1], and Doug Karcher[1]

Additional index words: Putting green, creeping bentgrass, *Agrostis stolonifera*, golf ball launcher

Young, J., M. Richardson and D. Karcher. 2012. Evaluating Ball Mark Severity and Recovery Using Digital Image Analysis. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:50-55.



Platform designed to determine ball mark severity using digital image analysis.

Summary. Digital image analysis has been successfully used to evaluate turfgrass cover and color along with performance traits like golf ball lie, and allows researchers to obtain less subjective data in a timely manner. New studies at the University of Arkansas plan to evaluate ball mark severity and recovery of creeping bentgrass under various management regimes. Ball marks on putting greens may affect aesthetics and golf ball roll, so bentgrass cultivars that heal more quickly would be advantageous for golf course managers. The use of digital image analysis to obtain this data seemed appropriate, but specific methods need to be developed and studied to ensure effectiveness. A newly developed camera platform resulted in strong correlations between volume of a ball mark and ball mark severity calculated using digital image analysis. A pneumatic golf ball launcher was designed to fire golf balls from consistent height and angle necessary to determine if treatments vary in ball mark severity. Digital image analysis also proved successful in calculating recovery of ball marks over time using a cover analysis. The success of these methods in all areas confirms that digital image analysis can be used in ball mark studies.

Abbreviations: DIA, digital image analysis; DAT, days after treatment

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Digital image analysis is a relatively new technique that has been used in agronomic research to evaluate crop coverage, disease severity, and color differences with fertility. Based on the quality of data produced with DIA in these areas, turfgrass researchers began working with this system to determine similar properties of turfgrass. Visual turf quality ratings have been the chief piece of information obtained to differentiate turfgrass cultivars or management practices for many years. Scientists performing these ratings on a regular basis can be highly consistent in rating turf over time; however, it may be difficult to compare data collected by various researchers because of the subjectivity of the ratings. The use of DIA to determine turfgrass coverage and color (Richardson et al., 2001; Karcher and Richardson, 2003) can eliminate the subjectivity of visual turf quality ratings because digital images could be obtained and evaluated using specific parameters that could be duplicated by researchers in any location.

To date, usage of DIA in turfgrass research has expanded to playability characteristics. Golf ball lie, divot recovery, traffic tolerance, and mower scalping have been evaluated using techniques previously described (Richardson et al., 2010). The potential uses of DIA have not been exhausted and new techniques come to mind regularly that have to be evaluated to determine their usefulness for further research. The majority of ball mark research to this point investigated recovery of ball marks that were repaired with various methods or tools compared to unrepaired ball marks (Munshaw et al., 2007; Murphy et al., 2003). One study performed by Nemitz et al. (2008) studied ball mark severity and recovery under two different firmness conditions. The methods for determining ball mark severity and recovery in these studies were tedious measurements like filling cellophane paper lining the ball mark with sand to determine volume or measuring injured area diameter periodically with a ruler to calculate ball mark recovery. The objective of this research was to determine if ball mark severity and recovery could be successfully evaluated using DIA for future research projects.

Materials and Methods

Ball mark severity. A platform similar to the platform used for determining ball lie was developed to allow digital images to be captured from an equidistant focal point (Richardson et al., 2010). The minor modifications on the new frame were extending the focal length and removing the nuts and bolts used to adjust the previous frame to the turfgrass height of cut. The digital camera and settings were the same as previously reported for the ball lie frame (Richardson et al., 2010).

A preliminary study was conducted to ensure the newly designed frame could be used to measure ball mark severity. A 2-inch thick block of modeling clay was placed between two, 2-inch cement blocks to support the frame. A red golf ball was pressed down into the clay in approximately 0.1 inch (3 mm) increments obtaining images of the ball as it was pressed deeper into the clay (Fig. 1). SigmaScan Pro 5 (Systat Software Inc., San Jose, Calif.) was used to determine the number of red pixels above the surface of the clay. The actual volume of the ball mark was determined by weighing the amount of dried sand of a known bulk density necessary to fill the indention. Ball mark severity calculated from DIA was correlated to actual volume of the ball mark to ensure this method could successfully measure ball mark severity.

A pneumatic golf ball launcher was fabricated to produce consistent ball marks from plot to plot, so ball mark severity could be evaluated accurately (Fig. 2). The barrel of the golf ball launcher was made of 1.5-inch diameter PVC pipe. The golf ball launcher was secured to a tripod to ensure consistency in height and angle of descent. An air compressor was attached to the launcher to maintain constant air pressure for firing golf balls. Previous ball mark studies incorporating pneumatic golf ball launchers reportedly fired balls at 15 psi, but their instruments had longer barrels with the ball being released within a foot of the putting surface (Munshaw et al., 2007; Murphy et al., 2003). Golf balls were fired into the putting green at 20, 30, 40, 50, 60, and 70 psi to determine the appropriate pressure to create a normal sized ball mark. Based on visual evidence, 40 psi was selected as the best pressure to fire golf balls.

Ball mark recovery. Ball mark recovery was evaluated using cover analysis once ball marks became necrotic (Richardson et al., 2001). Subsequent images were collected on three to seven day intervals. A light box was used to maintain consistent light conditions for each image. The light box was attached to a purple foam board with a 4-inch diameter cut-out in the center. The frame was centered over the ball mark injury to obtain images. A golf tee marked two frame corners, so the ball marks could be located more quickly with the camera. A cover analysis was performed in SigmaScan Pro 5 to select green pixels within the cut-out area. Injury area (mm^2) was calculated by determining the number of non-selected pixels and multiplying by mm^2/pixel. The hue (65 to 100) and saturation (15 to 100) thresholds for running the cover analysis had to be adjusted as summer heat stress progressed and algae began growing within the ball marks.

Results and Discussion

Ball mark severity. The calibration test was successful in demonstrating a strong relationship between volume of the ball mark and ball mark severity as determined using digital image analysis (Fig. 3). The spherical shape of the golf ball being analyzed as a two-dimensional image may have created the cubic polynomial curve observed. Nonetheless, these data confirmed that DIA could be used to measure ball mark severity. Previous researchers either weighed sand added to cellophane wrap lining the ball mark to determine volume or established a visual rating system for ball mark severity. Utilizing DIA to measure ball mark severity will decrease the length of time to collect data and result in a quantifiable percentage that can be analyzed statistically.

Ball mark recovery. A modified cover analysis was successfully used to determine recovery of ball marks over time (Fig. 4). The cover analysis described by Richardson et al. (2001) was modified to reduce shadowing from the frame, fill areas of necrotic turf, and decrease noise within the ball mark. The initial injury of ball marks appeared similar to heat stressed turf with a purple discoloration. For this reason, ball mark injury images were not obtained until 2 DAT, so ball marks became necrotic to ease the ability of software to select green tissue around the injured area. Performing this research during summer heat stress may be difficult, especially if the turf becomes chlorotic due to various stressful putting green management practices or if algae begin growing in the areas of ball mark injury.

Conclusions

Digital image analysis was a successful method to measure ball mark severity and recovery. A preliminary study confirmed that ball mark severity could be determined using a newly designed platform. The development of a pneumatic golf ball launcher allowed for consistent creation of ball marks to evaluate ball mark severity under various management practices. Ball mark recovery data may be difficult to ascertain depending on the health of non-injured turf, but adjusting the macro and thresholds within the software allowed for adequate recovery analysis over time. These methods can be performed more quickly with less subjectivity compared to previous methods used in ball mark studies. The instrumentation and methods described could be incorporated into ball mark studies at other locations or research studies to evaluate ball marks.

Literature Cited

Karcher, D.E. and M.D. Richardson. 2003. Quantifying turfgrass color using digital image analysis. Crop Sci. 43:943-951.

Munshaw, G.C., B.R. Stewart, H.W. Philley, and D.W. Wells. 2007. Ball mark repair: Is it the tool, or how you use it? Online. Applied Turfgrass Science. doi:10.1094/ATS-2007-0816-01-RS.

Murphy, J.A., T.J. Lawson, and J. Clark. 2003. Ball marks on bentgrass. USGA Turfgrass and Environmental Research Online 2(12):1-6.

Nemitz, J.R., C.A. Bigelow, and A.C. Moeller. 2008. Surface firmness and repair tool affect golf ball mark recovery. Online. Applied Turfgrass Science. doi:10.1094/ATS-2008-1121-01-RS.

Richardson, M.D., D.E. Karcher, and L.C. Purcell. 2001. Quantifying turfgrass cover using digital image analysis. Crop Sci. 41:1884-1888.

Richardson, M.D., D.E. Karcher, A.J. Patton, and J.H. McCalla Jr. 2010. Measurement of golf ball lie in various turfgrasses using digital image analysis. Crop Sci. 50:730-736.

Fig. 1. Setup used for preliminary study to determine if the newly designed frame could successfully measure ball mark severity.

Fig. 2. Pneumatic golf ball launcher designed to fire golf balls from a consistent height and angle required to differentiate ball mark severity in plots subjected to various management practices.

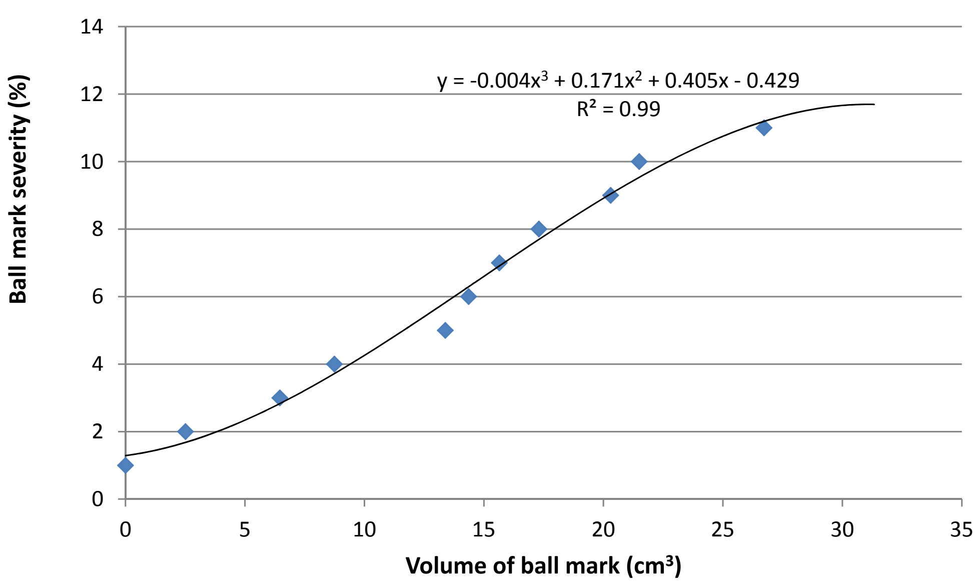


Fig. 3. Preliminary study illustrated the strong correlation between volume of a ball mark and ball mark severity calculated from digital image analysis.

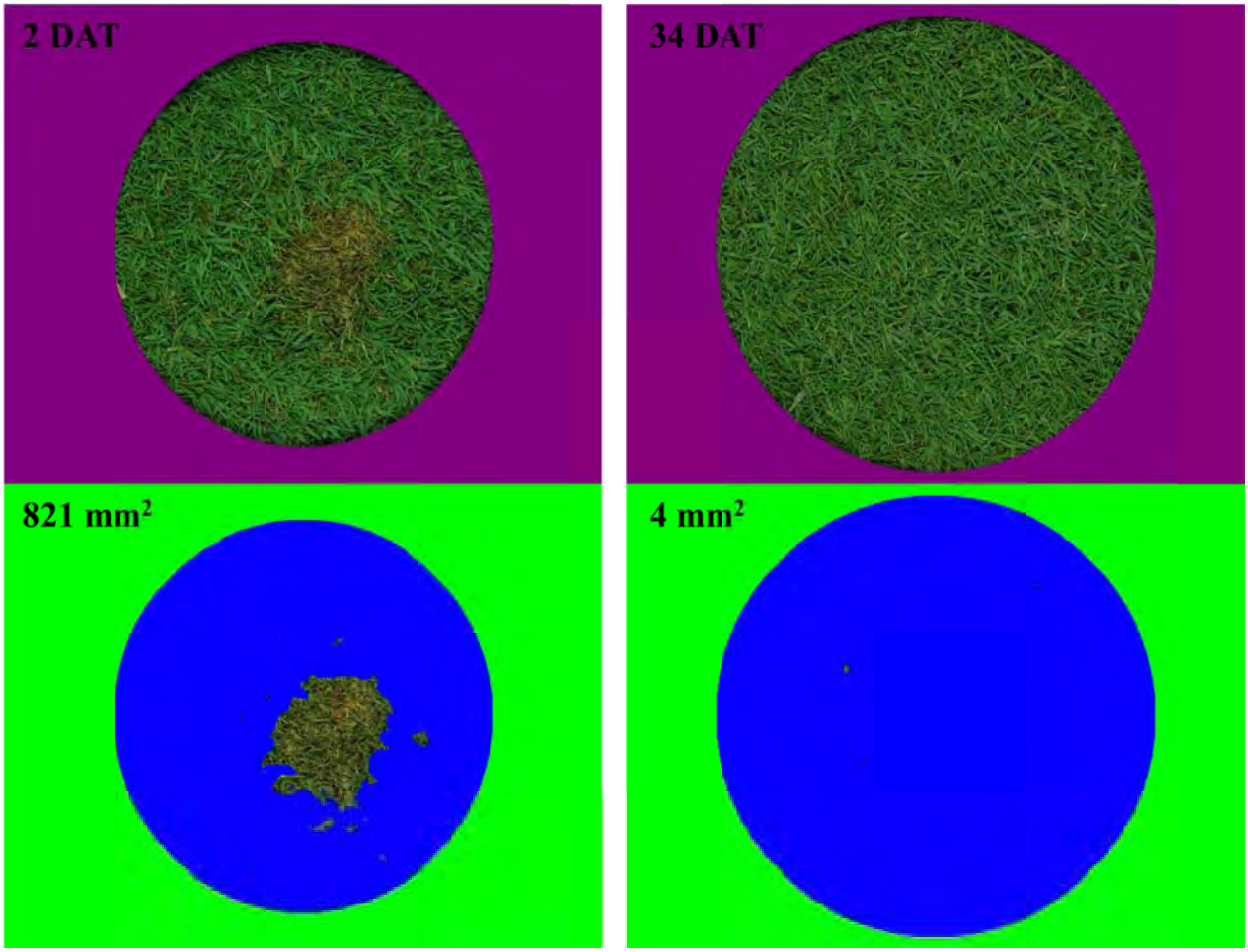


Fig. 4. Ball mark recovery analysis performed to illustrate the effectiveness of the cover analysis to determine ball mark injury area's change over time.

Ball Mark Severity and Recovery Under Low Mowing, Rolling, and Foot Traffic

Joseph Young[1], Mike Richardson[1], and Doug Karcher[1]

Additional index words: creeping bentgrass, putting green, digital image analysis.

Young, J., M. Richardson and D. Karcher. 2012. Ball Mark Severity and Recovery Under Low Mowing, Rolling, and Foot Traffic. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:56-62.

Photo by Joey Young

Ball marks created by pneumatic ball mark launcher in rolling frequency plots.

Summary. Ball mark injury affects both aesthetic and playability characteristics of putting greens. Most ball mark studies have evaluated repair tools or repair techniques to determine if recovery occurs more rapidly based on the method of repair. Digital image analysis techniques were incorporated in the present study to determine if ball mark severity or recovery was influenced by low mowing heights, increased rolling, and foot traffic. The hypothesis for this research was that firmer conditions would result in smaller ball marks with minimal turf injury. It was believed that lower mowing heights combined with increased traffic from equipment or golfers would impede ball mark recovery due to increased physiological stress. Ball mark severity was not significantly different for any treatments evaluated in 2010. In contrast, rolling frequency appeared to have an effect on ball mark recovery with plots rolled six times per week having significantly greater ball mark injury area than plots not rolled with the exception of SR 1020 at 34 days after treatment (DAT). The differences observed in recovery over time for rolling frequencies may have been a result of initial differences in injury area 2 DAT, rather than an indication of slower recovery over time with increased rolling. These data indicate that maintaining adequate moisture and decreasing rolling frequency will minimize the duration of ball mark injury on putting greens.

Abbreviations: DIA, digital image analysis; TDR, time-domain reflectometer; GCSAA, Golf Course Superintendents Association of America; DAT, days after treatment

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Ball marks on putting greens are a serious issue golf course superintendents must battle on a consistent basis. These necrotic impressions disrupt playability and aesthetic qualities of the putting surface. Previous ball mark research has included volumetric measurements of the indention and differences in recovery among cultivars utilizing rulers to measure the reduction in scar area over time (Murphy et al., 2003). The ultimate goal for most ball mark research was to determine variations in ball mark recovery with different ball mark repair tools or techniques (Fry et al., 2005; Munshaw et al., 2007; Nemitz et al., 2008).

Digital image analysis (DIA) is a relatively new technique in turfgrass research, but has been successfully used to measure turf color and coverage along with performance traits like golf ball lie (Karcher and Richardson, 2003; Richardson et al., 2001; Richardson et al., 2010). A newly developed technique utilizing DIA to rapidly collect data on ball mark severity and recovery was recently described (Young et al., 2011). The objective of this study was to determine if ball mark severity and recovery on creeping bentgrass putting greens are affected by mowing height, rolling frequency, and foot traffic. To date, no researchers have evaluated ball marks under these conditions, some of which should create high stress situations that may slow recovery rate. We hypothesize that ball marks will be smaller and heal more quickly with firmer, drier surfaces associated with increased rolling; however, as traffic from equipment or golfers becomes excessive, the rate of recovery will likely lessen.

Materials and Methods

This experiment was conducted at the University of Arkansas Research and Extension Center in Fayetteville from June to July 2010 on 'SR 1020' and 'Penn G-2' creeping bentgrass (*Agrostis stolonifera*) putting greens. The treatments evaluated were mowing height, rolling frequency, and foot traffic (Table 1). All plots received approximately 0.1 lb N/1,000 ft^2 biweekly during the study as well as routine applications of plant growth regulator, wetting agent, and fungicide typical of putting greens in this region. Light topdressing was applied to the entire area biweekly during the study period. Irrigation was applied to prevent drought stress.

Methods to simulate and monitor ball marks are described in a companion paper (Young et al., 2011). Briefly, two ball marks were created in each plot on 22 June 2010 with a pneumatic golf ball launcher fired at 40 psi. Just prior to making ball marks, time-domain reflectometer (TDR) measurements (FieldScout TDR 300, Spectrum Technologies, Plainfield, Ill.) determined volumetric soil moisture levels of individual plots in the top 1.5 inch of soil. A red golf ball was pressed into each resultant ball mark. Digital images from the front and rear views of the golf ball were obtained with the camera mounted on a platform to ensure equidistant focal length for each image (Fig. 1). Images were analyzed in SigmaScan Pro 5 (Systat Software Inc., San Jose, Calif.) to determine the percentage of red pixels attributed to the visible portion of the golf ball as compared to the red pixels attributed to a red golf ball sitting on the putting green surface (Richardson et al., 2010). The calculated values were subtracted from 100 and averaged to determine the percent of golf ball below the putting green surface or ball mark severity.

Approximately four hours after ball marks were created, ball marks were repaired using the method recommended by the GCSAA (Golf Course Superintendents Association of America, 2011). The initial recovery images were collected 2 days after treatment (DAT), once the injured area had become necrotic. Subsequent images were obtained on three to six day intervals until 35 DAT. A cover analysis was performed for each image, selecting green pixels within a 4-inch cutout of a purple frame (Young et al., 2011). The area of injury was calculated based on the non-selected pixels within the frame of known area.

Results and Discussion

Ball mark severity. There were no statistical differences in ball mark severity identified for any of the treatment combinations or main treatments individually. Ball mark severity was positively correlated with volumetric water content for both cultivars evaluated (Fig. 2). As expected, ball mark severity increased as volumetric water content increased and vice versa. In contrast, the relationship between ball mark severity and maximum injury observed was in opposition to the hypothesis. There was not a clear relationship observed for Penn G-2's ball marks; however, the less severe ball marks (smaller volume) on SR 1020 resulted in the greatest scar area at 2 DAT (Fig. 3). Greater maximum injury was observed for the shallower ball marks, possibly indicating the foliage absorbed the impact in drier conditions, whereas softer conditions offered less resistance and diverted the energy of the impact to soil and thatch layer. The lack of a relationship for Penn G-2 may have been due to increased turf density, minimizing the surface area in contact with the golf ball.

Ball mark recovery. The main factor that resulted in significant ball mark recovery differences was rolling frequency. On all except one rating date (SR 1020 at 34 DAT), plots rolled six times per week had significantly greater ball mark injury compared to plots that were not rolled. Although there were significant differences for each date, the rate of recovery was similar across rolling treatments (Fig. 4). Based on this observation, the initial difference in ball mark scar area may be the main factor leading to differences in ball mark injury over time rather than rolling frequencies leading to reduced recovery rates. Plots that were rolled more frequently would have firmer surfaces leading to greater initial ball mark injury as previously described for differences in ball mark severity.

Conclusions

No differences in ball mark severity (volume) were observed for either SR 1020 or Penn G-2 maintained with these treatment combinations. This study was initiated prior to most of the heat stress experienced in Northwest Arkansas (Richardson and Karcher, 2011), so significant differences may have occurred if ball marks were created during peak heat stress periods. Differences in ball mark recovery appeared to be most influenced by rolling frequency. On most dates for both bentgrass cultivars, plots that were not rolled had significantly less ball mark scar area compared to plots rolled six times per week. However, the rate of recovery appears to be similar over time for all rolling treatments, suggesting the main difference would be the initial size of the ball mark injury. These results indicate that if putting greens are maintained with adequate soil moisture, ball mark severity will not be significantly increased and the initial ball mark injury area will remain smaller healing slightly quicker.

Literature Cited

Fry, J.D., T.A. McClellan, and S.J. Keeley. 2005. Ball mark repair and creeping bentgrass recovery. Online. Applied Turfgrass Science. doi:10.1094/ATS-2005-0801-01-RS.

GCSAA. 2008. Repairing ball marks. Online. Golf Course Facts, Golf Course Superintendents Assoc. of Amer., Lawrence, KS. http://www.gcsaa.org/Course/Communication/Information-for-Golfers/Repairing-ball-marks.aspx.

Karcher, D.E. and M.D. Richardson. 2003. Quantifying turfgrass color using digital image analysis. Crop Sci. 43:943-951.

Munshaw, G.C., B.R. Stewart, H.W. Philley, and D.W. Wells. 2007. Ball mark repair: Is it the tool, or how you use it? Online. Applied Turfgrass Science. doi:10.1094/ATS-2007-0816-01-RS.

Murphy, J.A., T.J. Lawson, and J. Clark. 2003. Ball marks on bentgrass. USGA Turfgrass and Environmental Research Online 2(12):1-6.

Nemitz, J.R., C.A. Bigelow, and A.C. Moeller. 2008. Surface firmness and repair tool affect golf ball mark recovery. Online. Applied Turfgrass Science. doi:10.1094/ATS-2008-1121-01-RS.

Richardson, M.D. and D.E. Karcher. 2012. 2010 Weather Summary for Fayetteville, Arkansas. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:97-98.

Richardson, M.D., D.E. Karcher, and L.C. Purcell. 2001. Quantifying turfgrass cover using digital image analysis. Crop Sci. 41:1884-1888.

Richardson, M.D., D.E. Karcher, A.J. Patton, and J.H. McCalla Jr. 2010. Measurement of golf ball lie in various turfgrasses using digital image analysis. Crop Sci. 50:730-736.

Young, J.R., M.D. Richardson, and D.E. Karcher. 2012. Evaluating ball mark severity and recovery using digital image analysis. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:50-55.

Table 1. Brief description of treatments being applied to SR 1020 or Penn G-2 study area.

Treatment	Plot size	Description
Mowing height	12 ft x 18 ft	Whole plots mowed 6 days/wk with a Toro Flex 21 walk mower. Mowing heights consisted of 0.100, 0.125, and 0.156 inch
Rolling frequency	4 ft x 18 ft	Rolling treatments were applied with a Tru-Turf Greens Roller as a single pass through both cultivars. Rolling frequencies were 0, 3, or 6 days/wk.
Foot traffic	4 ft x 9 ft	Traffic was applied five times from 22 June to 25 August 2010 by five researchers walking in each plot for two minutes wearing golf shoes with alternative spikes.

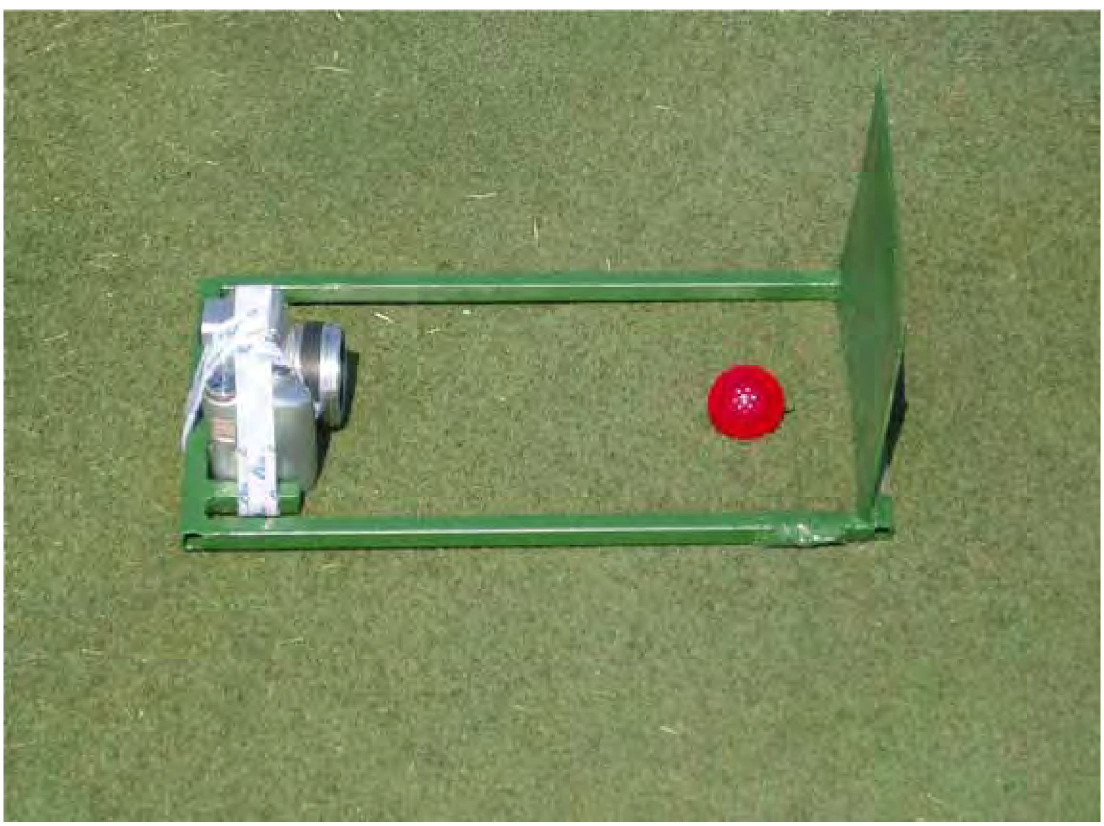


Fig. 1. Digital image analysis platform used to measure ball mark severity.

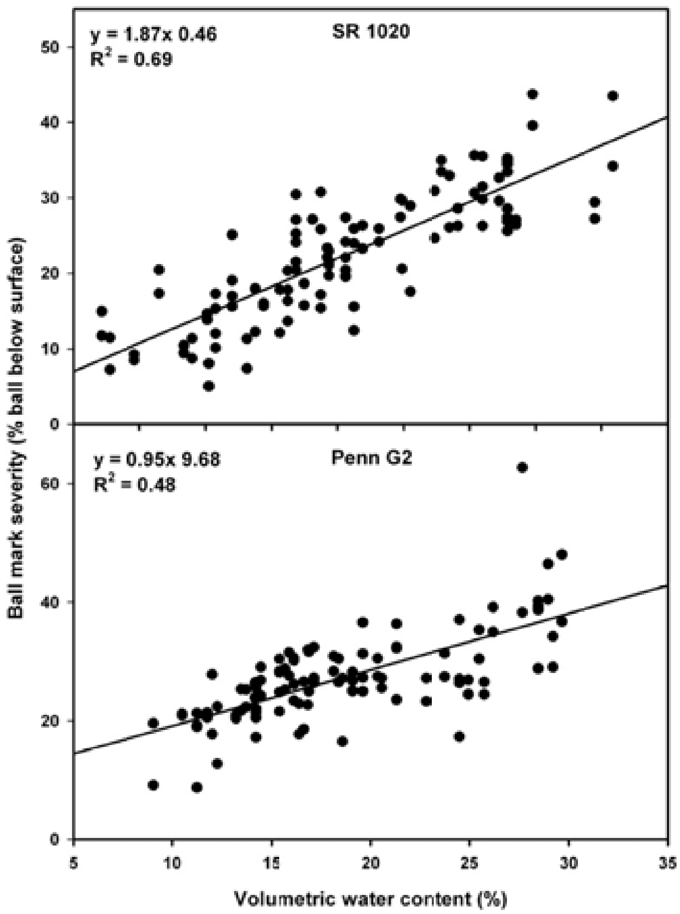


Fig. 2. Relationship between volumetric water content and ball mark severity. Volumetric water content was measured using a time-domain reflectometer instrument. Ball mark severity is a measurement of percent golf ball below the putting green surface.

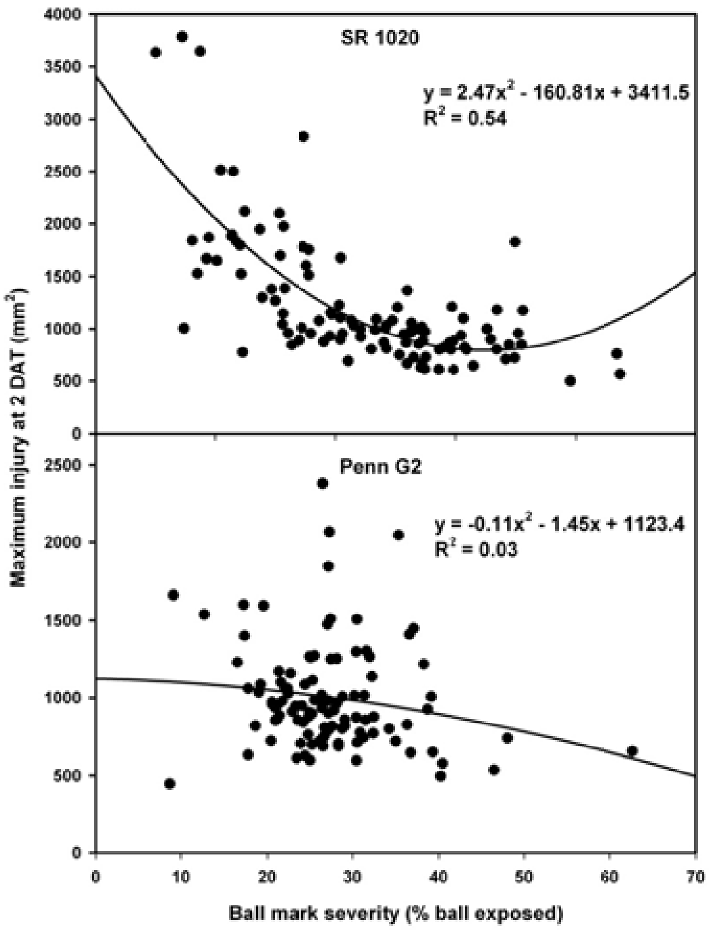


Fig. 3. Relationship between ball mark severity and maximum injury. Ball mark severity is a measurement of percent golf ball below the putting green surface. Maximum injury area was observed 2 days after treatment and affected area was calculated using digital image analysis.

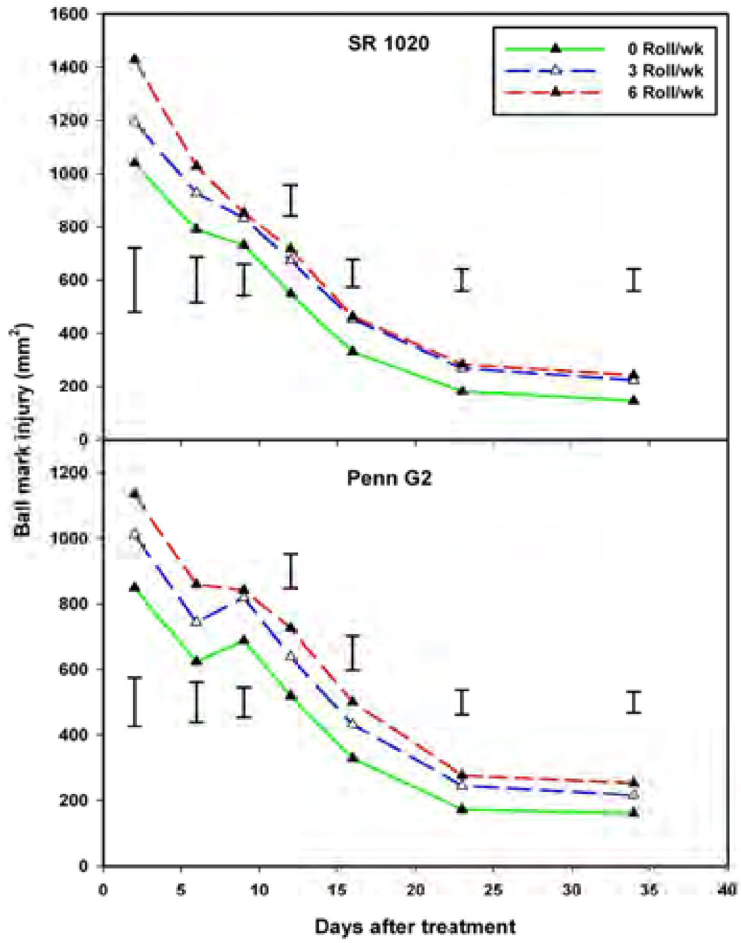


Fig. 4. Ball mark recovery over time affected by rolling frequencies. Ball mark injury area was determined using digital image analysis by converting the number of non-selected pixels within a 4-inch frame to an injury area measurement (mm^2). Plots rolled 6 times/wk had significantly larger ball marks than plots not rolled on each rating date for both cultivars with the exception of the final rating date for SR 1020. Error bars represent Fisher's least significant difference (α = 0.05).

Rooting Characteristics of Creeping Bentgrass as Affected by Mowing Height, Rolling, and Traffic

Joseph Young[1], Mike Richardson[1], and Doug Karcher[1]

Additional index words: putting green, low mowing, WinRHIZO, root mass, root length, root diameter

Young, J., M. Richardson and D. Karcher. 2012. Rooting Characteristics of Creeping Bentgrass as Affected by Mowing Height, Rolling, and Traffic. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:63-66.

Photo by Joey Young

Rooting samples cleaned prior to analysis with the WinRHIZO system.

Summary. Few mowing and rolling studies have evaluated the effect of these practices on rooting characteristics. Root scanning technology produces a myriad of data from a single sample, including cumulative root length, specific area, and root diameter. The objective of this study was to evaluate these rooting parameters under mowing, rolling, and foot traffic. Root samples of SR 1020 and Penn G-2 creeping bentgrass were collected in June and August 2010 and analyzed using the WinRHIZO system. Cumulative root length, root diameter, and dry root mass were reduced drastically from June to August for both cultivars. However, few significant differences among treatments were observed for samples collected on the individual dates. Plots of SR 1020 receiving foot traffic had significantly less cumulative root length and dry root mass compared to SR 1020 plots that were not exposed to extra foot traffic on the August sampling date. There were trends in the data that suggested more rooting at higher mowing heights, but the differences were not statistically significant at $\alpha = 0.05$. This research will give golf course superintendents managing creeping bentgrass in the transition zone rooting data that can be used when selecting appropriate management practices for their putting greens during summer heat stress.

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Many studies have demonstrated the effects of lower mowing heights and increased traffic on the above-ground portion of turf; however, only a few have observed what effects these treatment factors have on turfgrass roots. Processing samples for root analysis is a laborious process. Since roots play a pivotal role in the physiological health of the foliar portion of the plant, more information is needed to understand how various management practices affect root physiology and function.

Previous studies have demonstrated decreased root length when creeping bentgrass (*Agrostis stolonifera*) was subjected to low mowing heights or increased temperatures (Huang and Gao, 2000; Liu and Huang, 2002; Sifers et al., 2001). Root dry mass data are commonly reported in many studies to indicate a reduction in root production, but these data may not indicate where the reduction occurred. Roots may have reduced lengths, smaller diameters, or fewer numbers. Recently designed technology, the WinRHIZO (Regent Instruments Inc., Quebec, Canada) software, analyzes root scans and performs numerous calculations such as cumulative root length, surface area, and diameter among others. The objective of this study was to evaluate cumulative root length, root diameter, and dry root mass as affected by mowing height, rolling frequency, and foot traffic.

Materials and Methods

This experiment was conducted at the University of Arkansas Research and Extension Center in Fayetteville from May to September 2010. All treatments were applied to 'SR 1020' and 'Penn G-2' creeping bentgrass. The treatments evaluated were mowing height, rolling frequency, and foot traffic (Table 1). All plots received approximately 0.1 lb N/1,000 ft^2 biweekly during the study as well as routine applications of plant growth regulator, wetting agent, and fungicide typical of putting greens in this region. Light topdressing was applied to the entire area biweekly during the study period. Irrigation was applied to prevent drought stress.

Two random samples were collected from each plot in June and August 2010 using a profile sampler (Turf-Tec International, Tallahassee, Fla.) (3-inch × 0.5-inch) to a 4-inch depth. Foot traffic applications had not begun by the initial root sampling date in June, so the only treatment factors that were evaluated on that date were mowing height and rolling frequency. The majority of sand and organic matter was washed from the samples supported on a sieve. The top 0.8 inch of verdure and thatch were removed from each sample prior to further organic matter removal in a bucket of water. Cleaned roots were placed in a rectangular dish with water and separated to avoid overlapping root material. The rectangular dish was placed on a scanner (Epson Perfection V700, Epson America Inc., Long Beach, Calif.) and the WinRHIZO software initiated the scanning and analysis process. Roots from the two samples were combined, placed in a drying oven for 48 hours, and weighed to obtain root dry mass.

Results and Discussion

Few significant differences were observed in cumulative root length, root diameter, or dry root mass on the two sampling dates. The combination of the treatments and the severe summer conditions experienced in 2010 (Richardson and Karcher, 2011) greatly reduced cumulative root length, root diameter, and root mass from June to August (Table 2). Cumulative root length and dry root mass were reduced by approximately 75% and 80%, respectively. Root diameter was decreased by approximately 30% from June to August 2010. The only treatment that resulted in a significant difference in rooting characteristics was foot traffic applications on the August sampling date for SR 1020. Plots that received foot traffic had significantly less cumulative root length and dry root mass on the August sampling date (Table 2), but no differences in root diameter were observed on this sampling date.

Similar to previous studies, the treatments combined with heat stress throughout the summer months decreased cumulative root length, root diameter, and dry root mass (Huang et al., 1998; Huang and Gao, 2000; Liu and Huang, 2002). None of these studies evaluated the effect of these treatment combinations on root morphology as performed in the current study. It was hypothesized that plots maintained at a higher mowing height and receiving less rolling and foot traffic would retain greater root material. Penn G-2 appeared to be affected by foot traffic to a lesser degree later in the summer since significant differences were not observed in this cultivar, which was likely due to increased heat tolerance as suggested by Liu and Huang (2002) and Sifers et al. (2001). In those studies, newer, finer textured bentgrass cultivars exhibited less negative effects from increased heat stress compared to standard bentgrass cultivars. Although not statistically significant at $\alpha = 0.05$, there were trends ($P \leq 0.1$) that suggested increased mowing heights had a positive impact on rooting characteristics.

Conclusions

Few significant differences in cumulative root length, root diameter, or dry root mass were observed from samples obtained in June and August 2010. Each factor was reduced drastically between June and August for both cultivars, but the reductions were similar for each treatment. The only significant differences observed were reductions in cumulative root length and root dry mass in plots receiving foot traffic at the August sampling date. Based on this data, increased traffic and extreme low mowing heights did not significantly reduce rooting in creeping bentgrass. Although few significant differences were observed, there were some potential trends that appeared to develop among the various mowing heights. These evaluations will be repeated in 2011 to determine if these trends may become clearer with continued maintenance at these different mowing heights and traffic treatments.

Literature Cited

Huang, B. and H. Gao. 2000. Growth and carbohydrate metabolism of creeping bentgrass cultivars in response to increasing temperatures. Crop Sci. 40:1115-1120.

Huang, B., X. Liu, and J.D. Fry. 1998. Effects of high temperature and poor soil aeration on root growth and viability of creeping bentgrass. Crop Sci. 38:1618-1622.

Liu, X.Z. and B.R. Huang. 2002. Mowing effects on root production, growth, and mortality of creeping bentgrass. Crop Sci. 42:1241-1250.

Richardson, M.D., and D.E. Karcher. 2012. 2010 Weather summary for Fayetteville, Arkansas. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:97-98.

Sifers, S.I., J.B. Beard, and M.L. Fraser. 2001. Botanical comparisons of twelve Agrostis cultivars in a warm-humid climate. Int. Turfgrass Soc. Res. J. 9:213-217.

Table 1. Brief description of treatments being applied to SR 1020 or Penn G-2 study area.

Treatment	Plot size	Description
Mowing height	12 ft x 18 ft	Whole plots mowed 6 days/wk with a Toro Flex 21 walk mower. Mowing heights consisted of 0.100, 0.125, and 0.156 inch.
Rolling frequency	4 ft x 18 ft	Rolling treatments were applied with a Tru-Turf Greens Roller as a single pass through both cultivars. Rolling frequencies were 0, 3, or 6 days/wk.
Foot traffic	4 ft x 9 ft	Traffic was applied five times from 22 Jun to 25 Aug 2010 by five researchers walking in each plot for two minutes wearing golf shoes with non-metal spikes.

Table 2. Mean cumulative root length, root diameter and dry root mass for main treatment factors of mowing height, rolling frequency, and foot traffic for samples collected in 2010.

Cultivar	Treatment factor	Treatment. description	Cumulative root length (cm)		Root diameter (mm)		Dry root mass (g)	
			June	August	June	August	June	August
SR 1020	Mowing height	0.100 inch	4447	1284	0.201	0.135	0.308	0.051
		0.125 inch	4878	1628	0.207	0.135	0.380	0.073
		0.156 inch	5123	1764	0.204	0.140	0.406	0.080
	Rolling frequency	0 times/wk	4754	1588	0.206	0.138	0.369	0.069
		3 times/wk	5069	1593	0.201	0.138	0.370	0.070
		6 times/wk	4626	1494	0.204	0.134	0.355	0.065
	Foot traffic	No	---	1734[a]	---	0.137	---	0.076[a]
		Yes	---	1383[a]	---	0.136	---	0.060[a]
Penn G-2	Mowing height	0.100 inch	4676	1125	0.196	0.138	0.332	0.070
		0.125 inch	5030	1463	0.191	0.145	0.366	0.062
		0.156 inch	4640	1312	0.197	0.144	0.341	0.057
	Rolling frequency	0 times/wk	4751	1388	0.199	0.143	0.374	0.082
		3 times/wk	4865	1343	0.191	0.144	0.329	0.058
		6 times/wk	4730	1169	0.197	0.141	0.336	0.048
	Foot traffic	No	---	1307	---	0.143	---	0.071
		Yes	---	1293	---	0.142	---	0.060

[a]Values are significantly different with $\alpha = 0.05$.

Effects of Mowing, Rolling, and Foot Traffic on Quality and Coverage of Creeping Bentgrass Putting Greens

Joseph Young[1], Mike Richardson[1], and Doug Karcher[1]

Additional index words: 'SR 1020', 'Penn G-2', visual rating, digital image analysis, heat stress

Young, J., M. Richardson and D. Karcher. 2012. Effects of Mowing, Rolling, and Foot Traffic on Quality and Coverage of Creeping Bentgrass Putting Greens. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:67-73.

Photo by Joey Young

Cultivar SR 1020 plot maintained at 0.100 inch exhibits lighter color and qulaity compared to surrounding plots at the end of May.

Summary. Previous studies have demonstrated reduced turf quality when grasses are mowed at lower heights or subjected to heavy traffic. These results may be exacerbated in cool-season grasses during summer months due to increased environmental stresses. Although low mowing heights and heavy traffic have been evaluated as individual factors, research is lacking on the effect of turf quality when these stress factors are combined. The objective of this study was to determine the effects of mowing height (0.100, 0.125, or 0.156 inch bench height setting), rolling frequency (0, 3, or 6 days per week), and foot traffic on turf quality and coverage of two creeping bentgrass cultivars (SR 1020 and Penn G-2) managed as a putting green. Initially, the highest mowing height had the worst turf quality for both cultivars due to the overabundance of foliar tissue that reduced uniformity. Penn G-2 plots mowed at 0.125 inch had higher turf quality ratings in July and September compared to plots maintained at 0.156 inch, whereas SR 1020 plots at the highest height maintained better turf quality than lower mowing heights on those dates. Significant differences in turfgrass coverage were not observed until the final month, although there was a large reduction in coverage from June to July. Therefore, treatment differences in September may have occurred due to slowing recovery rather than physical damage or injury due to treatments.

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

It is generally accepted that turfgrass maintained below optimal mowing heights or exposed to frequent high traffic will have reduced turf quality and coverage. Mowing heights of putting green turf continues to decrease as a means to increase green speeds. Turf scientists often recommend increasing mowing heights during periods of environmental stress; however, some turfgrass managers may be hesitant due to potentially slowing green speed. The use of rollers over the last decade has surged, alleviating some concern of slower green speeds with increased mowing heights. Although decreased turf quality has been observed with excessively low mowing or high traffic, researchers have not evaluated low mowing and heavy traffic from equipment or foot traffic in combination. The objective of this study was to determine the effects of mowing height, rolling frequency, and foot traffic on two creeping bentgrass (*Agrostis stolonifera*) cultivar's quality and coverage.

Materials and Methods

This experiment was conducted at the University of Arkansas Research and Extension Center in Fayetteville from May to September 2010. Treatments were applied to 'SR 1020' and 'Penn G-2' creeping bentgrass. The treatments evaluated were mowing height, rolling frequency, and foot traffic (Table 1). All plots received plant growth regulators, fertilizers, wetting agents, and fungicides to maintain adequate growth and prevent disease symptoms. Light topdressing was applied to the entirety of the study area biweekly during the study period. Irrigation was applied equally to both cultivars to prevent drought stress.

Visual turf quality ratings were obtained monthly from 17 June to 5 September 2010. Each plot was rated on a 1-9 scale (1 = poor quality; 6 = minimum acceptability; 9 = best quality). Following visual ratings, two digital images were obtained of each plot using a light box (20 × 24 inch). A cover analysis of these images was performed using SigmaScan Pro 5 (Systat Software Inc., San Jose, Calif.) (Richardson et al., 2001). Data from the two images were averaged to get percent turf coverage for an individual plot.

Results and Discussion

Turf Quality. Significant differences in turf quality were observed for SR 1020 in June and July, but not September. In June, SR 1020 maintained at 0.156 inch had significantly worse turf quality than other mowing heights due to excessive foliar tissue that reduced turfgrass uniformity (Fig 1.). Rolling frequency had a significant effect on turf quality of SR 1020 in both June and July with plots rolled 6 times/wk, having significantly worse turf quality than non-rolled plots (Fig. 2). Significant differences in quality of SR 1020 were observed in July with a 6% reduction when foot traffic was applied.

Turf quality differed significantly on each rating date for Penn G-2. In June, plots mowed at 0.156 inch and rolled 0 or 3 times/wk had significantly worse turf quality than other treatments except plots mowed at 0.100 inch and rolled 6 times per week (Fig. 3). Similar to SR 1020 in July, Penn G-2 quality was significantly reduced by rolling (Fig. 2) and foot traffic (7% reduction). By the end of summer, plots maintained at 0.100 inch with foot traffic had the worst turf quality (data not shown). The combination of increased traffic and low mowing heights caused negative effects on turf quality throughout the summer months.

The results for both creeping bentgrass cultivars indicated that lower mowing heights and rolling would be advantageous when environmental conditions are conducive for cool season grass growth and development. As temperatures began to warm in early summer, the amount of rolling and foot traffic appeared to have greater effects on turf quality than mowing height. Although quality was decreased in both cultivars as temperatures increased, no treatment resulted in unacceptable turf quality ratings. It was surprising that Penn G-2 plots maintained at 0.125 inch had higher quality than plots maintained at 0.156 inch throughout the summer 2010 (Fig. 1). The newer, denser bentgrasses were bred to be managed at low mowing heights (Fraser, 1998), and these data were demonstrative of this fact. However, data suggested that standard cultivars could maintain higher quality with increased mowing heights and rolling during extreme summer conditions.

Turf Coverage. No significant differences in turfgrass coverage were observed on either cultivar for any treatment until the final rating date in September. SR 1020 plots rolled 6 times per week had significantly less turf coverage than plots rolled every other day or not at all (Fig. 4). In contrast, Penn G-2 was significantly affected by mowing height and foot traffic. Penn G-2 mowed at 0.125 or 0.156 throughout the summer had significantly greater coverage than plots mowed at 0.100 (Fig. 5). Plots that received foot traffic had significantly less turf coverage (98.6%) than plots not exposed to foot traffic (99.6%). Although no significant treatment differences were observed in July, SR 1020 and Penn G-2 coverage were reduced by 10% and 9%, respectively. By the final rating date, mean turf coverage for both cultivars had increased back to 99%, similar to initial coverage data obtained for June. Differences in turfgrass coverage on this final observation date were likely caused by slower recovery with low mowing and increased traffic. In the future, these ratings will be conducted more regularly to better depict the trends of reduction and recovery of turfgrass coverage.

Conclusion

Turf quality was lowest in plots maintained at the highest mowing height (0.156 inch) early in the summer. The excessive amount of foliage combined with the upright growth habit expressed by both cultivars reduced the uniformity of turf, decreasing turf quality. This trend continued throughout the summer for Penn G-2 with plots mowed at 0.125 inch having better turf quality than plots maintained at 0.156 inch on each rating date. Increased traffic combined with low mowing heights began to negatively affect turf quality and coverage as heat stress was more prevalent into the summer. Although turf quality and coverage were reduced with low mowing and increased traffic, plots remained acceptable throughout the summer months. This data demonstrates the options golf course managers have when determining management strategies. Based on this data, putting greens will maintain acceptable quality with low to moderate mowing heights throughout summer months. Incorporating rolling will allow greens to have increased green speeds without quality of creeping bentgrass putting greens becoming unacceptable.

Literature Cited

Fraser, M.L. 1998. Managing the new cultivars of creeping bentgrasses. Golf Course Management (August):53-56.

Richardson, M.D., D.E. Karcher, and L.C. Purcell. 2001. Quantifying turfgrass cover using digital image analysis. Crop Sci. 41:1884-1888.

Table 1. Brief description of treatments being applied to SR 1020 or Penn G-2 study area.

Treatment	Plot size	Description
Mowing Height	12 ft x 18 ft	Whole plots mowed 6 days/wk with a Toro Flex 21 walk mower. Mowing heights consisted of bench height settings at 0.100, 0.125, and 0.156 inch.
Rolling Frequency	4 ft x 18 ft	Rolling treatments were applied with a Tru-Turf Greens Roller as a single pass through both cultivars. Rolling frequencies were 0, 3, or 6 days/wk.
Foot traffic	4 ft x 9 ft	Traffic was applied five times from 22 June to 25 August 2010 by five researchers walking in each plot for two minutes wearing golf shoes with alternative spikes.

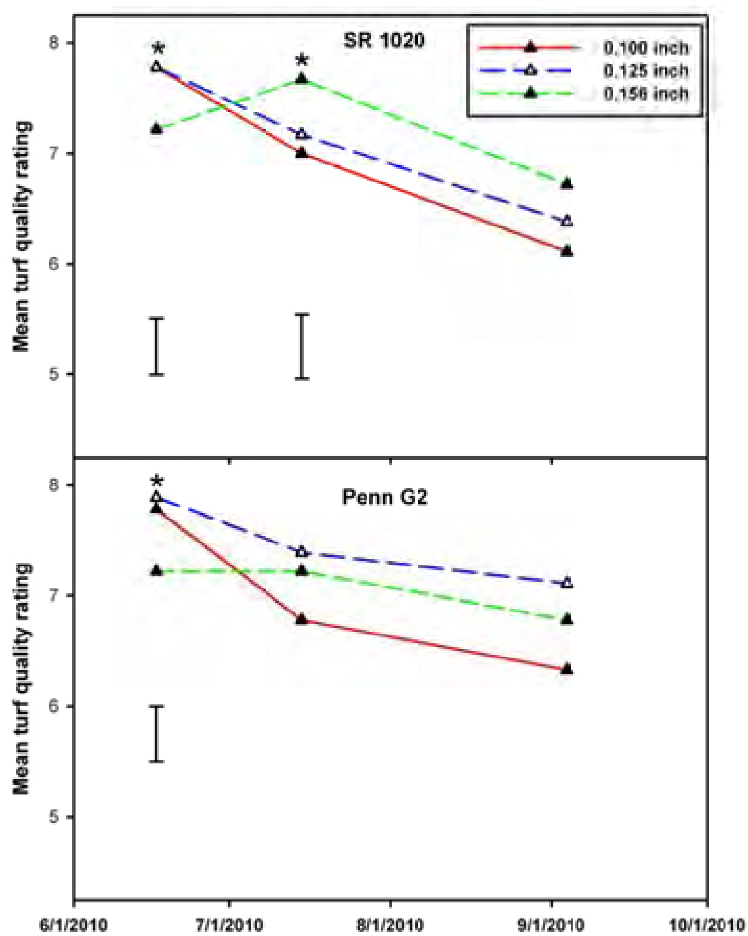


Fig. 1. Mean turf quality ratings (1-9 scale with 9 = best) for three mowing heights evaluated throughout the summer 2010. Error bars represent Fisher's LSD (α = 0.05), and asterisks indicate significant differences.

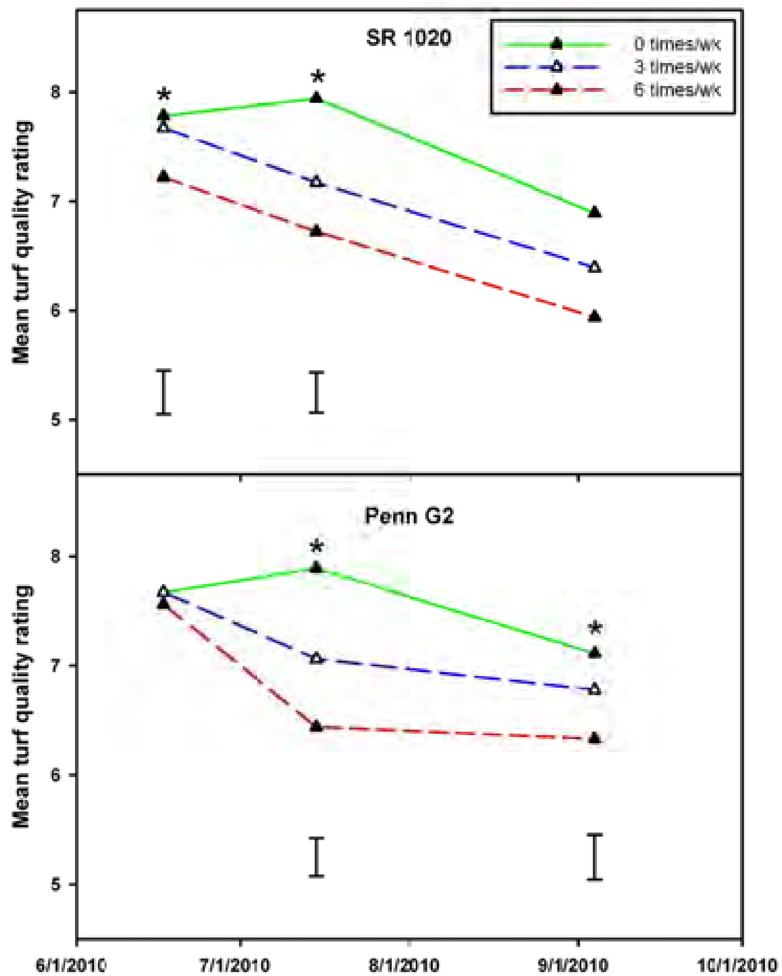


Fig. 2. Mean turf quality ratings (1-9 scale with 9 = best) for three rolling frequencies evaluated throughout the summer 2010. Error bars represent Fisher's LSD (α = 0.05), and asterisks indicate significant differences.

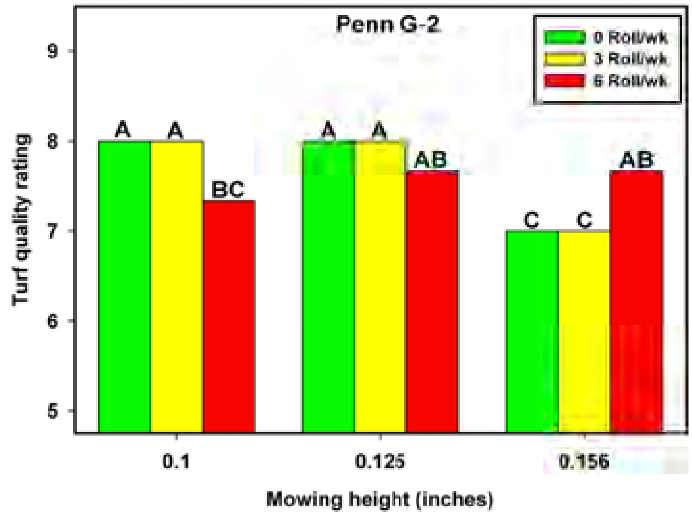


Fig. 3. Mowing by rolling interaction on Penn G-2 quality (1-9 scale with 9 = best) on 17 June 2010. Mean separation was conducted using least significant differences at α = 0.05. Bars with different letters are significantly different.

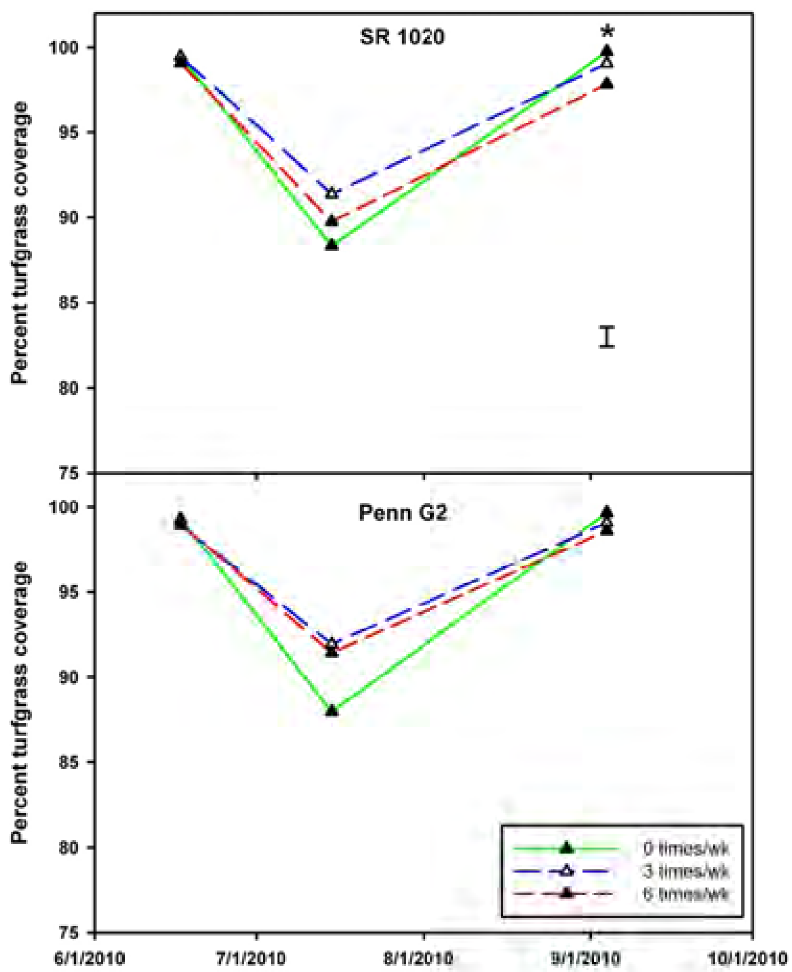


Fig. 4. Mean turf coverage determined by digital image analysis for three rolling frequencies evaluated throughout the summer 2010. Error bars represent Fisher's LSD (α = 0.05), and asterisks indicate significant differences.

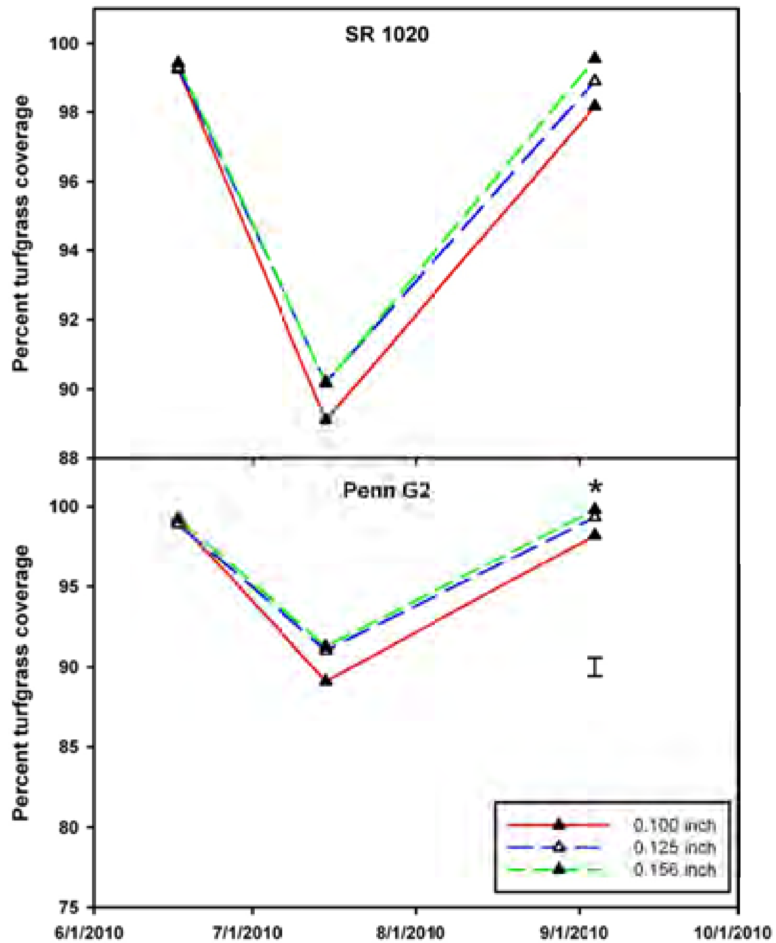


Fig. 5. Mean turf coverage determined by digital image analysis for three mowing heights evaluated throughout the summer 2010. Error bars represent Fisher's LSD (α = 0.05), and asterisks indicate significant differences.

Planting Method Affects Rooting Characteristics of Sports Turf During Establishment

Josh Anderson[1], Doug Karcher[1], Mike Richardson[1], and Aaron Patton[2]

Additional index words: bermudagrass (*Cynodon dactylon*), Zoysiagrass (*Zoysia japonica*), Kentucky bluegrass(*Poa pratensis*), Pre-harvest aerified sod, washed sod, soil-based sod, sand-capped rootzone

Anderson, J., D. Karcher, M. Richardson, and A. Patton. 2012. Planting Method Affects Rooting Characteristics of Sports Turf During Establishment. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:74-78.

Photo by Josh Anderson

Different establishment methods of Kentucky bluegrass, zoysiagrass, and bermudagrass sod planted on sand-based and native soil rootzones.

Summary. When establishing golf or sports turf from sod, the soil brought in with sod often does not match the existing root zone material, which can create a problematic layer in the soil profile. The objective of this study was to determine the effects of establishment method and rootzone soil type on rooting and turf quality of a sports field. Soil-based sod, washed sod, and pre-harvest aerified sod were established on sand-capped and native soil areas. Results thus far have indicated differences in soil types with regard to root length and rooting strength. Pre-harvest aerified sod had greater rooting strength and deeper roots in the native soil root zone, while washed sod had greater rooting strength and deeper roots in the sand-capped root zone. The results demonstrated that alternative establishment methods can enhance rooting while having minimal effects on visual turf quality.

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701
[2] Purdue University, Department of Agronomy, West Lafayette, Ind. 47907

The intense use of sports fields and golf tees increases traffic and wear, and often requiring the re-establishment of worn areas. Resurfacing with sod is the quickest way to recover such areas to a safe and playable form. Due to budgetary constraints, time restrictions, and the location of sod farms, the rootzone brought in with the new sod rarely matches the rootzone of the existing playing surface. The layering of different soil types can restrict water and airflow, which in turn can affect rooting characteristics such as rooting strength and root length. Rooting strength affects not only the stability of the sports turf, but is also a safety concern for the athletes whose performance depends on stability of the turf during activities. Also, root length is an important aspect in the plants ability to acquire water and nutrients. Since most sports field managers aerify the sod to improve infiltration and root growth within the first year of establishment, alternative establishment methods such as washing or core aerifying the sod prior to establishment may enhance rooting characteristics.

Materials and Methods

This experiment was conducted from April through July in 2010 at the University of Arkansas Research and Extension Center in Fayetteville, Ark. Sand–capped (5-inch depth) rootzones were constructed alongside native soil rootzones (Captina silt-loam) in March 2010, and established with either 'Patriot' bermudagrass (*Cynodon dactylon*), 'Meyer' zoysiagrass (*Zoysia japonica*), or 'Midnight' Kentucky bluegrass (*Poa pratensis*) in April and May 2010. Within the experimental area, the establishment methods were randomized and replicated four times.

Establishment. Three establishment methods of sod were used: soil-based sod, washed sod, and pre-harvest aerified sod. Within the experimental area, the establishment methods were randomized and replicated four times. All sod was cut at a depth of 1.5 inch with an 18-inch wide, walk-behind Ryan Jr. (Schiller Grounds Care Inc., Johnson Creek, Wis.) sod cutter. Washed sod was attained by pressure washing soil from soil-based sod. Aerification of pre-harvest aerified sod was performed 1 to 2 weeks prior to establishment with a Toro Pro-core 648 (The Toro Company, Bloomington, Minn.) equipped with 0.5-inch diameter hollow tines on a 1.0 × 2.0 inch spacing. The cores were then collected and removed. Kentucky bluegrass was established on 21 April, whereas bermudagrass and zoysiagrass were established on 25 May through 28 May. All sod was hand watered thoroughly during the first week of establishment.

Management. Mowing was performed 2 to 3 times per week during the growing season. Warm-season species were mowed at 0.5 inch and Kentucky bluegrass was mowed at 1.0 inch. Two irrigation zones were installed to accommodate the differences in water requirements for sand and soil rootzones to maintain deep and infrequent irrigation. Nitrogen fertilizer was applied every two weeks during the growing season at a rate of 1 lb/1000 ft^2 per month of active growth. Pesticides were selected and applied as needed in a manner typical of sports field management practices.

Evaluations. Two 4.0-inch diameter sod rings were installed in each plot during establishment. At 4 weeks after establishment (WAE) and 8 WAE the rings were pulled with an automated device (Chatillon Force Measurement Systems, Largo, Fla.) attached to the sod rings to measure rooting strength as vertical detachment in Newtons (N) as a unit force (Fig. 1). Maximum and average root lengths were visually assessed next to a ruler after detachment at 4 and 8 WAE (Fig. 3). Visual turf quality was rated at 4 and 8 WAE. Quality ratings were based on overall turf quality and took into account drought stress, coverage, and disease pressure. Ratings ranged from 1-10 with 10 having the highest quality and 6 or above being acceptable.

Results and Discussion

Rooting Strength. Rooting strength was significantly lower in soil-based sod than in washed or aerified sod for bermudagrass with force measurements being 5 and 6 N lower respectively (Fig. 2). No significant differences in establishment method were observed in zoysiagrass. In Kentucky bluegrass, aerified sod consistently had greater rooting strength than standard sod at both 4 and 8 WAE with forces measuring 7 and 4.5 N greater at the respective WAE (Fig. 2). Washed sod had the lowest rooting strength at 4 WAE, but the greatest rooting strength at 8 WAE (Fig. 2). Pressure washing soil from roots may have damaged root structure or fine-textured roots of Kentucky bluegrass more so than bermudagrass or zoysiagrass. This may have resulted in partially damaged and recovering Kentucky bluegrass roots at 4 WAE; however, the root system may have fully recovered by 8 WAE.

Root Length. Maximum and average root lengths were significantly higher in sand-capped rootzones when compared to native soil rootzones. Root lengths in the sand-capped rootzones measured at least double those of the native soil rootzones (Fig. 3). Average root lengths for bermudagrass, zoysiagrass, and Kentucky blugrass in the sand-capped rootzones ranged from 2.00 and 3.00 inches and 0.75 and 1.30 inches for the native soil rootzone. Maximum root lengths ranged from 4.30 and 5.90 inches for the sand-capped rootzones and 1.40 and 2.70 inches for the native soil rootzones. In zoysiagrass, bermudagrass, and Kentucky bluegrass, the lowest average and maximum root lengths in the sand-capped rootzones were greater than the greatest average and maximum root lengths in the native soil rootzones. No significant differences were observed in establishment method.

Turf Quality. Differences in visual turf quality were only observed in Kentucky bluegrass. Visual turf quality was significantly lower for washed sod at 4 WAE on both sand-capped and native soil rootzones. At 8 WAE, washed sod had quality ratings significantly lower than aerified sod in native soil and sand-capped rootzones (Fig. 4). Visual turf quality was only unacceptable (below 6) for washed sod in the native soil rootzone at 4 WAE (Fig. 4). This could possibly be accounted for due to the damaged root system of the washed sod during the 4 WAE.

Conclusion

Data from this study demonstrate that alternative establishment methods, such as core aerifying sod prior to harvest and washing sod, has shown to enhance rooting during the first year following establishment. In addition, these alternative establishment methods have had minimal effects on visual turf quality.

Fig. 1. Sod ring pulling device used to measure root strength by vertical detachment.

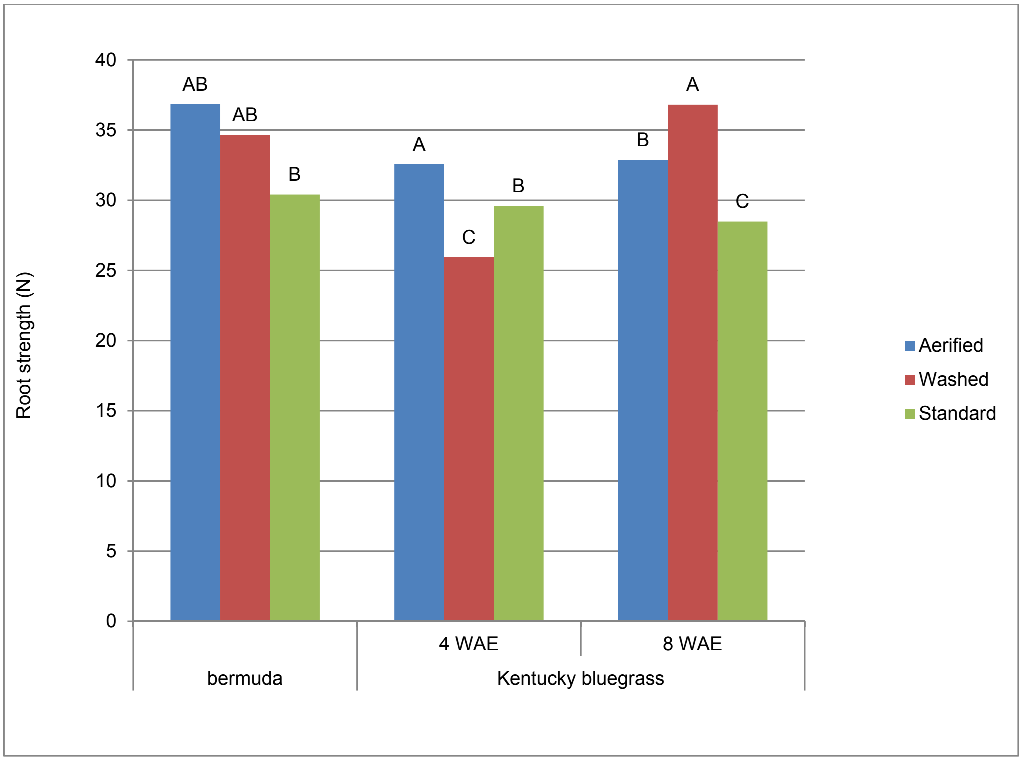


Fig. 2. Rooting strength for different establishment methods of 'Patriot' bermudagrass (averaged across evaluation dates), and 'Midnight' Kentucky bluegrass at 4 and 8 WAE. Bars not sharing a letter are significantly different according to Fisher's least significant difference test (α = 0.05).

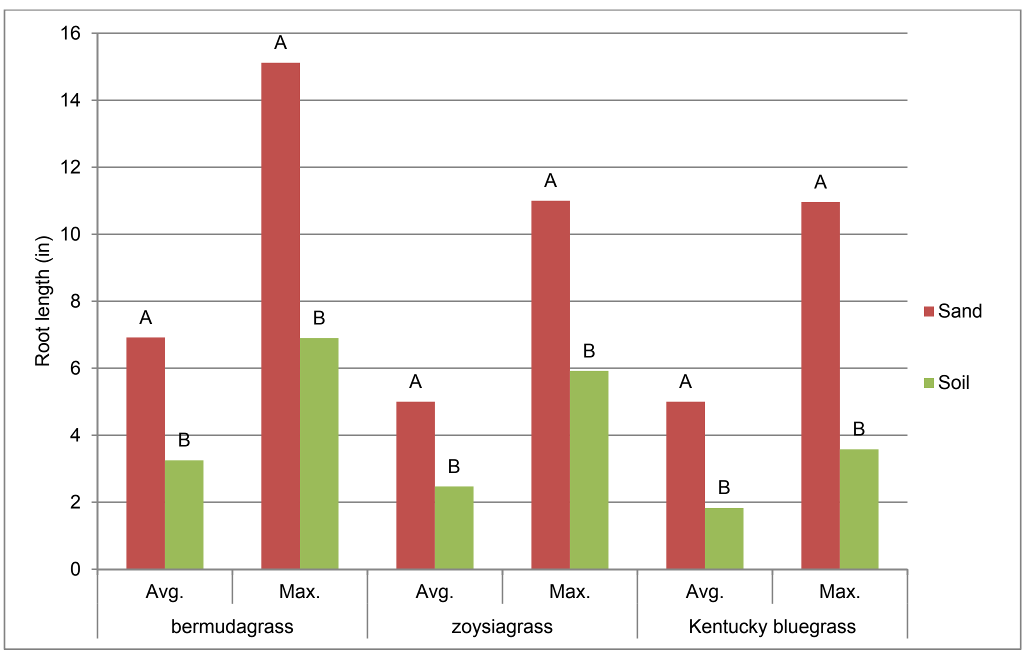


Fig. 3. Average and maximum root length for 'Patriot' bermudagrass, 'Meyer' zoysiagrass, and 'Midnight' Kentucky bluegrass grown on a sand-capped or native soil rootzone averaged across 4 and 8 WAE. Bars not sharing a letter are significantly different according to Fisher's least significant difference test (α = 0.05).

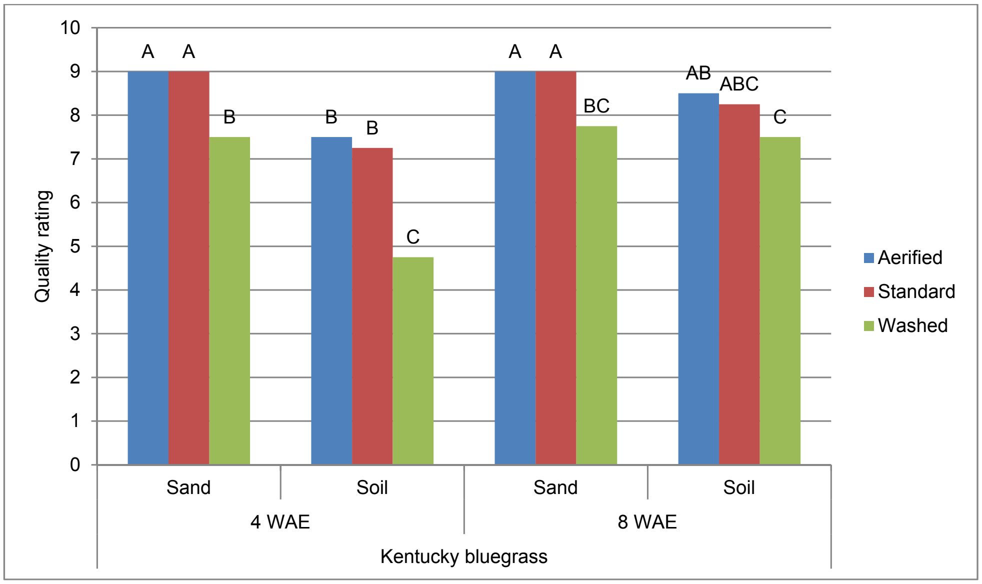


Fig. 4. Quality ratings for different establishment methods of 'Midnight' Kentucky bluegrass on sand-capped and native soil rootzones at 4 and 8 WAE. Bars not sharing a letter are significantly different according to Fisher's least significant difference test (α = 0.05).

Winter Hardiness of Thirty St. Agustinegrass Genotypes

David Moseley[1], Aaron Patton[2], and Jon Trappe[2]

Additional index words: Arkansas, *Stenotaphrum secundatum*, coverage, winterkill, digital image analysis, lawn

Moseley, D., A. Patton and J. Trappe. 2012. Winter Hardiness of Thirty St. Agustinegrass Genotypes. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:79-84.

Photo by Aaron Patton

Winter hardiness varied by St. Augustinegrass cultivar

Summary. St. Augustinegrass is currently used in central and southern Arkansas. It is mainly used for shaded lawns, as it is among the most shade tolerant warm-season turfgrass. Many new cultivars are being developed and are being considered for use in Arkansas, but prior to their adoption more data are needed on their winter hardiness. This experiment sought to determine the winter hardiness of several commercially available cultivars and experimental genotypes of St. Augustinegrass. Twenty commercially available cultivars and ten experimental genotypes were first grown as plugs in the greenhouse and then planted in research plots in Fayetteville, Ark. Plant materials were provided by University of Florida, Texas A&M University, Mississippi State University, North Carolina State University, and Double Springs Grass Farm in Searcy, Ark. Many of the new cultivars tested in this study have desirable attributes such as enhanced turf color, and faster establishment rates which may make them desirable for future use among Arkansas turf producers. Winter hardiness was evaluated on 27 May 2010 after a winter during which temperatures dipped below 5 °F on at least three dates. The cultivars Raleigh (NC), GF, TAES 5714, and 904AT2 had the highest (>6%) winter survival percentage when their percent coverage prior to winter was accounted for. Results from this study are intended to help residents of Arkansas make informed decisions when selecting turfgrass cultivars.

Abbreviations: DIA, Digital image analysis

[1] University of Arkansas, Cooperative Extension Service, Agriculture, Booneville, Ark. 72927
[2] Purdue University, Department of Agronomy, West Lafayette, Ind. 47907

St. Augustinegrass (*Stenotaphrum secundatum*) is a common lawn turf in Florida and Texas that has relatively wide leaf blades (0.2 to 0.4 inch) and spreads by stolons. St. Augustinegrass can make a quality lawn grass, but is undesirable for sports turf and golf due to its inability to tolerate low mowing heights and its poor traffic resistance and recovery. The favored climate for this turf species is warm, subtropical, and tropical climate regions and it is well-adapted to areas where irrigated. Currently, St. Augustinegrass is grown in central and southern Arkansas primarily in lawns that are shaded and not suited for bermudagrass. Several cultivars are known to be more winter hardy, disease resistant and chinch bug resistant than others (Busey, 2003a). The objective of this study was to evaluate St. Augustinegrasses in Fayetteville, Ark. to identify winter hardy cultivars that might be well-suited for use in Arkansas. Since winter hardiness is the most important factor in selecting a St. Augustinegrass cultivar in Arkansas, these results should be considered before selecting cultivars based on quality, establishment rate, and stolon growth rate.

Materials and Methods

Twenty commercially-available cultivars and ten experimental cultivars were established on 30 June 2009. The 3 by 3-inch plugs were grown in the greenhouse from plant material provided by University of Florida, Texas A&M University, Mississippi State University, North Carolina State University, and Double Springs Grass Farm in Searcy, Ark. Raleigh St. Augustinegrass was obtained both from the University of Florida and North Carolina State University and will be referred to as either Raleigh (NC) or Raleigh (FL) throughout the paper. The experimental plots were 4 by 4 ft arranged in a randomized complete block design with four replications. One plug was planted in the center of each plot. Plots were irrigated as needed to prevent wilting and were fertilized with 1 lb N/1000 ft^2 in July and August. The plots were not mown so that stolon growth was not disturbed and weeds were manually removed during establishment.

Coverage was determined using digital images of each plot taken with a digital camera mounted on a monopod to ensure a consistent height from the lens to the soil surface. Digital image analysis (DIA) was used to determine plot cover (Richardson et al., 2001). Images were taken of green cardstock with a known area and data were converted from selected green pixels to coverage. Winter survival was calculated as follows: [(coverage after winter dormancy ÷ coverage before winter dormancy on 13 September) * 100].

Results and Discussion

Following the cold temperatures in the 2009-2010 winter (Fig. 1), twelve cultivars (Amerishade, Bitterblue, Captiva, DALSA 0406, Floralawn, Floratam, Floratine, Floraverde, FX-10, Jade, Mercedes, and Seville) had no surviving plant material (Table 1). Among the plant material that survived, Raleigh (NC), GF, TAES 5714, and Deltashade had the most coverage on 27 May 2010 (Table 1).

Winter survival also varied among cultivars (Table 1). Raleigh (NC), GF, TAES 5714, and 904AT2 had the highest (>6%) winter survival percentage when their percent coverage prior to winter was accounted for. Majestic, Deltashade, Raleigh (FL), Classic, Texas Common, Palmetto, 106G3, MSA 2-3-98, and WS had intermediate winter survival (3-5%). SV27, 106T3, Sapphire, Sunclipse, and Delmar had 0.1% to 2.7% winter survival. These survival rates were calculated using 27 May coverage data, but it is important to point out that this was simply a snapshot of the data and that surviving plant material continued to spread and increase coverage during the summer.

The results from this study show that Raleigh (NC) has good cold tolerance which is consistent with previous reports (Maier et al., 1994a; Maier et al., 1994b; Philley et al., 1996; Wilson et al., 1977; Milla-Lewis et al., 2009). Raleigh was collected from a home lawn in Raleigh, N.C., developed by Dr. W.B. Gilbert at North Carolina State University, and released in the early 1980s (Milla-Lewis et al., 2009).The Raleigh St. Augustinegrass used in this study was obtained both from the University of Florida and North Carolina State University. Although both should be genetically identical, recent research has indicated that not all plant material sold as Raleigh St. Augustinegrass is genetically similar (Milla-Lewis et al., 2009). These two collections of Raleigh St. Augustinegrass did not have similar winter survival or coverage, which supports the hypothesis of Milla-Lewis et al. (2009) that the genetics of plant material being sold as Raleigh are variable. Raleigh St. Augustinegrass is available at four sod farms in Arkansas (Patton et al., 2008). It is unclear whether the Raleigh St. Augustinegrass being sold in Arkansas is genetically similar to that released by North Carolina State University, but this is very likely considering that it has performed well during cold winters in Little Rock.

New plant material (GF, SV27, WS, 904AT2) included in this study from North Carolina State University were developed from Raleigh St. Augustinegrass. Although these experimental genotypes were developed from Raleigh, only GF and 904AT2 had similar winter survival to Raleigh (NC) in this study. This is contrary to a previous report by Reynolds et al. (2009) on the winter survival of these experimental genotypes where they reported similar winter survival among all these genotypes and Raleigh at three separate North Carolina locations. Reynolds et al. (2009) reported that the low air temperature at each location in North Carolina never dropped below 17 °F, which could explain why the findings were different in Arkansas where the low temperature reached 1.4 °F (Fig. 1) and likely caused greater separation in the genotypes.

Previous reports on the field survival of commercially available St. Augustinegrass cultivars indicated that Mercedes and Delmar had winter survival similar to Raleigh (Philley et al., 1995; Philley et al., 1996). However, this research in Arkansas found that Raleigh had superior winter survival compared to Delmar and Mercedes. Philley et al. (1996) also reported that Seville, Sunclipse, Bitterblue, Floratam, Floralawn, and FX-10 had inferior winter survival compared to Raleigh, which is consistent with these findings. Busey (2003b) reported that Floratam, FX-10, and Seville could survive air temperatures as low as 15.8 °F, which is also consistent with findings in Arkansas where these grasses all winterkilled when air temperatures reached 1.4 °F in January.

Among the St. Augustinegrass cultivars available in Arkansas (Raleigh, Palmetto, Majestic, Texas Common) (Patton et al., 2008), only Raleigh had the highest coverage and survival percentage in this study. Palmetto, Majestic, and Texas Common were similar with an intermediate survival (3-5%). Experimental genotypes, GF and TAES 5714, were similar to Raleigh (NC) in coverage and winter survival percentage. Deltashade was similar to Raleigh (NC) in coverage and 904AT2 was similar to Raleigh (NC) in winter survival percentage. Raleigh (NC) had the highest winter survival percentage in this study with only 10.8% surviving. These results suggest that St. Augustinegrass should not be grown in the USDA Hardiness Zone 6b (Fayetteville, Ark.) or in zone 7a (Fort Smith, Ark.) where the average minimum temperature range is -5 to 0 °F or 0 to 5 °F, respectively (U.S Department of Agriculture, 1990). The cultivars with the highest surviving percentage and coverage may survive in zone 7b (e.g., Little Rock, Ark.) where the average minimum temperature range is 5 to 10 °F (U.S Department of Agriculture, 1990) and where a "urban heat-island" affect in Little Rock may help improve survival (Patton and Boyd, 2008).

Many of the new cultivars tested in this study have desirable attributes such as enhanced winter hardiness, dark green color, and fast establishment rates (Moseley et al., 2010a; Moseley et al., 2010b) which may make them desirable for future use among Arkansas turf producers. Results from this study are intended to help residents of Arkansas make informed decisions when selecting turfgrass cultivars. Planting well-adapted cultivars will improve turfgrass quality, and reduce reestablishment cost from winterkill and ultimately increase sustainability.

Literature Cited

Busey, P. 2003a. St. Augustinegrass. Pp. 309-330 *In*: Casler, M.D., and Duncan, R.R (eds.) Biology, breeding and genetics of turfgrasses. John Wiley and Sons, Inc, Hoboken, N.J.

Busey, P. 2003b. Winter survival of St. Augustinegrass cultivars. HortScience 38:1439-1440.

Maier, F.P., N.S. Lang, and J.D. Fry. 1994a. Freezing tolerance of three St. Augustinegrass cultivars as affected by stolon carbohydrate and water content. J. Amer. Soc. Hort. Sci.119:473-476.

Maier, F.P., N.S. Lang, and J.D. Fry. 1994b. Evaluation of an electrolyte leakage technique to predict St. Augustinegrass freezing tolerance. HortScience 29:316-318.

Milla-Lewis, S, X. Lin, M. Martin, C. Zuleta, A. Chandra, and K. Kenworthy. 2009. Assessment of molecular variability within St. Augustinegrass cultivar Raleigh using AFLP and SRAP markers. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, Wis.

Moseley, D., A. Patton, J. Trappe. 2010a. Leaf and stolon characteristics of commercially available and experimental St. Augustinegrass cultivars. Arkansas Turfgrass Report 2009, Ark. Ag. Exp. Stn. Res. Ser. 579:64-68.

Moseley, D., A. Patton, and J. Trappe. 2010b. Establishment rate of commercially available and experimental St. Augustinegrass cultivars. Arkansas Turfgrass Report 2009, Ark. Ag. Exp. Stn. Res. Ser. 579:95-98.

Patton, A.J. and J.W. Boyd. 2008. Lawn Care Calendar: St. Augustinegrass. Univ. of Arkansas Cooperative Extension Service Publication FSA-6119.

Patton, A.J., J.M. Trappe, and J. Boyd. 2008. 2008 Arkansas turfgrass sod source directory. Univ. of Arkansas Cooperative Extension Service Publication FSA-6136.

Philley, H.W., C.E. Watson Jr., J.V. Krans, J.M. Goatley Jr., and F.B. Matta. 1995. Differential thermal analysis of St. Augustinegrass. HortScience 30:1388-1389.

Philley, H.W., C.E. Watson Jr., V.L. Maddox, J.V. Krans, J.M. Goatley Jr., and M. Tomaso-Peterson. 1996. Turf Performance of St. Augustinegrass Cultivars in North Mississippi. Bulletin 1043. Mississippi State University.

Reynolds, W.C., R. Li, K. Silva, A.H. Bruneau, and R. Qu. 2009. Field performance of mutant and somaclonal variation lines of St. Augustinegrass [*Stenotaphrum secundatum* (Walt.) Kuntze]. Intl. Turfgrass Soc. Res. J. 11: 573-582.

Richardson, M.D., D.E. Karcher, and L.C. Purcell. 2001. Quantifying turfgrass cover using digital image analysis. Crop Sci. 41:1884-1888.

U.S. Dept. of Agric. 1990. Plant Hardiness Zone Map. USDA Misc. Pub. No. 1475. U.S. Dept. of Agric. Washington, D.C.

Wilson, C.A., J.A. Reinert, and A.E. Dudeck. 1977. Winter survival of St. Augustine grasses in north Mississippi. S. Nurserymen's Assoc. Res. Conf. Ann. Rep. 22:195-198.

Table 1. Winter survival of St. Augustinegrass cultivars in Fayetteville, Ark.

Cultivar	Blocks with surviving plant material	27 May coverage	27 May winter survival*
	%	cm^2	%
Raleigh¶¥ (NC)	100	404 a§	10.8 a§
GF	100	313 ab	9.6 ab
TAES 5714	75	296 ab	8.5 abc
904AT2	75	80 cd	6.8 a-d
Majestic¶¥	100	171 bcd	5.0 b-d
Deltashade ¶	100	208 abc	4.4 b-d
Raleigh¶¥ (FL)	100	159 bcd	4.2 b-d
Classic¶	100	175 bcd	3.9 c-d
Texas Common¶¥	100	166 bcd	3.6 c-d
Palmetto¶¥	100	142 bcd	3.4 c-d
106G3	75	69 cd	3.3 c-d
MSA 2-3-98	100	114 bcd	3.1 c-d
WS	100	165 bcd	3.1 c-d
SV27	100	67 cd	2.7 de
106T3	75	49 cd	1.5 de
Sapphire¶	25	75 cd	1.2 e
Sunclipse¶	50	21 cd	0.8 e
Delmar¶	25	4 d	0.1 e
Amerishade¶	0	.	.
Bitterblue¶	0	.	.
Captiva¶	0	.	.
DALSA 0406	0	.	.
Floralawn¶	0	.	.
Floratam ¶	0	.	.
Floratine ¶	0	.	.
Floraverde¶	0	.	.
FX-10	0	.	.
Jade¶	0	.	.
Mercedes¶	0	.	.
Seville¶	0	.	.
Average	50	149	4.2

*Winter survival was calculated as follows: [(coverage after winter dormancy ÷ coverage before winter dormancy on 13 September) * 100].

§Values followed by the same letter are similar. (α = 0.05). Within the winter survival column, values followed by the same letter are similar (α = 0.10). Cultivars with 0% survival in all four blocks were excluded from the analysis.

¶Commercially available in 2009.

¥Commercially available in Arkansas in 2009.

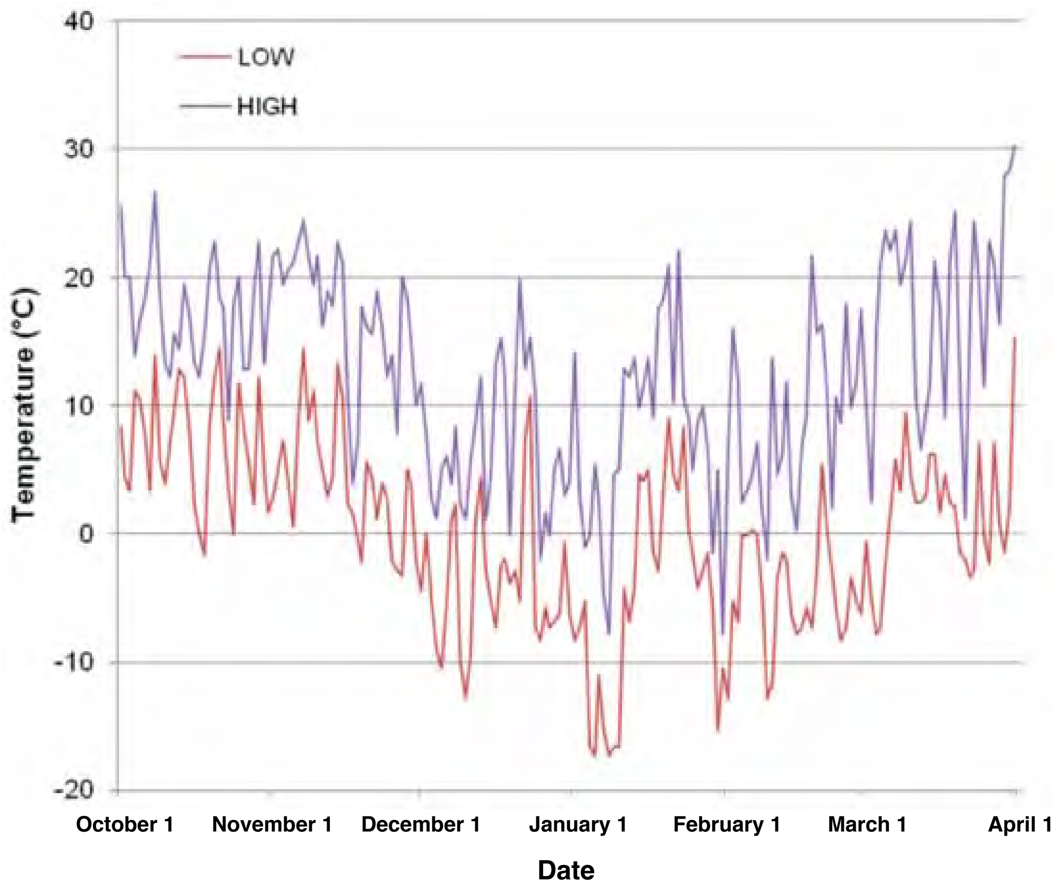


Fig. 1. Air temperature in the St. Augustinegrass cultivar trial in Fayetteville, Arkansas during the winter of 2009-2010.

Effects of ReTain on Creeping Bentgrass Putting Greens under Tournament Conditions

Dan Strunk[1], Doug Karcher[1], and Mike Richardson[1]

Additional index words: aminoethoxyvinylglycine hydrochloride, ethylene

Strunk, D., D. Karcher, and M. Richardson. 2012. Effects of ReTain on Creeping Bentgrass Putting Greens under Tournament Conditions. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:85-87.

Photo by Dan Strunk

The research putting green used to evaluate the effects of aminoethoxyvinylglycine hydrochloride on tournament recovery at the University of Arkansas. Pictured is 'Penn A-1' creeping bentgrass.

Summary. Creeping bentgrass is often used in areas of the United States, such as the transition zone, that are outside the optimum temperature range for the species. Recent studies have shown that under high-temperature stress, the production of the plant stress hormone ethylene was increased in creeping bentgrass in a growth chamber. In addition, other stressors such as wounding have been shown to stimulate ethylene production in many plants. Tournament conditions in putting green management in places where high-temperature stress is prevalent may be some of the most stressful conditions for turf. During tournaments, mowing heights are lowered, mowing frequency increased, light weight rolling added, and irrigation reduced to produce hard and fast putting surfaces. However, these practices are detrimental to the overall quality of the turf and slow the recovery afterwards. The objective of this study was to evaluate the effectiveness of an ethylene-inhibiting compound, aminoethoxyvinylglycine hydrochloride, on reducing the effects of tournament conditions on turfgrass quality. No significant differences were noted across any treatments from applications of aminoethoxyvinylglycine hydrochloride or the untreated control for turfgrass quality, color, relative chlorophyll content, or tiller density. The lack of differences may be attributed to a cooling of temperatures over the evaluation period.

Abbreviations: AVG, aminoethoxyvinylglycine hydrochloride

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Creeping bentgrass has an optimum growing temperature range of 15 °C to 24 °C for shoot growth (Beard, 1973), well below average temperature highs during the summer in the transition zone, an area of the United States where no turfgrass species is completely adapted (Dunn and Diesburg, 2004). Creeping bentgrass subjected to heat stress (>35 °C) in a growth chamber exhibited elevated ethylene levels after 14 days of heat stress. Subsequently, ethylene evolution was negatively correlated with turf quality, photosystem II efficiency, and chlorophyll and carotenoid contents in creeping bentgrass (Xu and Huang, 2007; Xu and Huang, 2009).

Regular mowing consistently wounds turf leaves, and occurs at least daily under normal maintenance procedures for creeping bentgrass putting greens. Double cutting (mowing twice daily) is often implemented for tournament play to further increase green speeds. Some courses may even triple or quad cut putting greens to maximize ball roll distance. Although ethylene production has not been studied regarding mowing of turf, wounding in other plant species has been shown to elevate the levels of ethylene. Increased production of ethylene may result in chlorophyll loss, increased leaf senescence, and reduced photosynthesis (Xu and Huang, 2007).

Light-weight rolling of greens is an effective tool to increase golf ball roll distance, but the impact of light-weight rolling on ethylene production has not been evaluated. Lightweight greens rollers smooth the putting surface and increase ball roll distance for several hours (Danneberger et al., 1993; Hamilton et al., 1994). However, the weight of these rollers, although relatively low, has the potential to crush leaf tissues, causing a wound response and increased ethylene production, and rolling more than every other day has been shown to negatively affect turfgrass quality (Hartwiger et al., 2001).

Therefore, the objectives of this study were to evaluate the effectiveness of an ethylene inhibiting compound, on reducing stress-related ethylene and determine if the ethylene inhibitor can prevent turfgrass quality degradation and promote recovery. It is likely that low mowing, double cutting, daily light-weight rolling, and extensive traffic increases ethylene production which may lead to leaf senescence and a decline in turfgrass quality, typically associated with tournament conditions. A substance that inhibits the ethylene production under stress conditions may improve putting green quality and recovery following tournament conditions. In this study, aminoethoxyvinylglycine hydrochloride (AVG) was the ethylene inhibiting compound used, a chemical commonly used in fruit and nut production. The compoud AVG inhibits ethylene production by reducing the enzymatic activity of 1-aminocyclopropane-1-carboxylic acid synthase, which prevents the accumulation of the ethylene precursor, 1-aminocyclopropane-1-carboxylic acid (Venburg et al., 2008).

Materials and Methods

This study was conducted on an established creeping bentgrass (*Agrostis stolonifera* cv. Penn A-1) during July and August in 2010. Maintenance procedures were initially consistent with regional standards. The putting green was mowed at a height of 0.125 inch six days per week, fertilized with a water soluble nitrogen source at a rate of 0.125 lbs of nitrogen per 1000 ft^2 every two weeks, and regularly irrigated to prevent drought stress. On 16 August 2010, tournament management practices were initiated. Mowing height was lowered daily by 0.010 inch from 0.125 inch to 0.085 inch, mowing was increased from single cutting to triple cutting, and rolling was implemented in two directions daily. Irrigation was reduced to hand watering to prevent localized dry spot. Tournament conditions lasted for one week before maintenance returned to regional standards.

Four treatments were included in a randomized complete block design with four replications. Treatments included applications of an ethylene inhibitor and an untreated control. Aminoethoxyvinylglycine hydrochloride (ReTain, Valent Biosciences Corporation, Walnut Creek, Calif.), an ethylene inhibitor, was applied at a rate of 56 g per acre at three different application timings: 1) before tournament conditions, 2) during tournament conditions, and 3) after tournament condition completion. All applications were made with a CO_2-spraying system and a TeeJet 8001 extended range flat fan spray nozzle (XR8001VS, TeeJet Technologies, Wheaton, Ill.). A spray shield was used to prevent contamination of neighboring plots.

Treatments were evaluated for turfgrass quality, relative chlorophyll content, color, and tiller density. Turfgrass quality, a combination of turfgrass color, density, and uniformity, was visually rated on a numerical scale weekly (1-9 scale; 1 = dead turf, 6 = acceptable). Relative chlorophyll content was determined using a chlorophyll meter (Fieldscout CM1000 Chlorophyll Meter, Spectrum Technologies Inc., Plainfield, Ill). Two chlorophyll readings were taken per plot per week. Turfgrass color was determined through digital image analysis (Karcher and Richardson, 2002). Digital images were captured weekly using an Olympus 510SP-UZ digital camera (Olympus Corporation, Center Valley, Pa.) mounted in a light box to prevent the effects of ambient lighting. Tiller density was determined by collecting three 0.59 in^2 plugs from each plot, and then counting the total number of tillers present. Tiller density was measured before experiment initiation and after completion.

Results and Discussion

No significant differences were noted for any of the evaluations for the study. Turfgrass quality had an overall mean of 7.4 with a range of 6 to 8 for the overall evaluation period. Turfgrass quality remained the same during the tournament period even though mowing heights were lowered and mowing frequency increased. Relative chlorophyll content was not significantly different for any treatments and ranged from 347 to 435 with an average of 403.6. Although the values for relative chlorophyll content decreased during tournament conditions, the values were not significantly different from the other testing dates. There were no differences among any of the treatments in turfgrass color. The dark green color index ranged from 0.709 to 0.721 with an average value of 0.718. Tiller density averaged 193.2 tillers per in^2 for all treatments with a range from 188.5 to 204.2. The lack of significant differences among the treatments for all of the measurements was likely affected by a cooling trend during the evaluation period. Temperatures were well above optimum prior to experimentation, but during the experiment, temperatures and humidity decreased creating a more suited environment for turfgrass growth.

Literature Cited

Beard, J.B. 1973. Turfgrass: Science and culture. Prentice-Hall, Englewood Cliffs, N.J. 668 pp.

Danneberger, K., E. McCoy, and T. Parobek. 1993. Rolling greens – help or hindrance? Ohio State University Turf News 17(5):13-14

Dunn, J. and K. Diesburg. 2004. Turf management in the transition zone. John Wiley & Sons, Inc., Hoboken, N.J. 280 pp.

Hamilton, G.W., D.W. Livingston, and A.E. Gover. 1994. The effects of light-weight rolling on putting greens. London: E&F.N. Spon Science and Golf II:425-430.

Hartwiger, C.E., C.H. Peacock, J.M. DiPaola, and K. Cassel. 2001. Impact of light-weight rolling on putting green performance. Crop Sci. 41:1179-1184.

Karcher, D.E. and M.D. Richardson. 2002. Quantifying turfgrass color using digital image analysis. Crop Sci. 43(3):943-951.

Venburg, G.D., R. Hopkins, J. Retamales, J. Lopez, J. Hansen, G.G. Clarke, M. Shroder, and A.C. Rath. 2008. Recent developments in AVG research. Acta Hort. 796:43-49.

Xu, Y. and B. Huang. 2007. Heat-induced leaf senescence and hormonal changes for thermal bentgrass and turf-type bentgrass species differing in heat tolerance. J. Am. Soc. Hortic. Sci. 132:1-8.

Xu, Y. and B. Huang. 2009. Effects of foliar-applied ethylene inhibitor and synthetic cytokinin on creeping bentgrass to enhance heat tolerance. Crop Sci. 49:1876-1884.

Mowing and Rolling Affect Wear Injury from Foot Traffic on Creeping Bentgrass Putting Greens

Joseph Young[1], Mike Richardson[1], and Doug Karcher[1]

Additional index words: low mowing, rolling, density, *Agrostis stolonifera*, heat tolerance

Joseph Young, Mike Richardson, and Doug Karcher. 2012. Mowing and Rolling Affect Wear Injury from Foot Traffic on Creeping Bentgrass Putting Greens. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:88-93.

Photo by Joey Young

Wear damage and spike marks observed following foot traffic application (right) compared to a non-trafficked plot (left).

Summary. Golf course putting greens experience stress in many forms. Traffic is constantly being applied to putting greens in the forms of maintenance equipment or foot traffic. The golf shoes worn by golfers create wear damage from the scraping, tearing action of the non-metal spikes and tread of the sole contacting leaf blades. Research has demonstrated increased wear damage from foot traffic under heat stress conditions. Theoretically, putting greens being managed at lower mowing heights with increased rolling frequency would exhibit greater wear from foot traffic due to increased physiological stress. The goal of this study was to determine the effect of foot traffic on two creeping bentgrass cultivars that were maintained at different mowing heights and under different rolling frequencies. Both creeping bentgrass cultivars exhibited increased wear damage further into the summer; however, Penn G-2 appeared to withstand the stress to a greater degree than SR 1020. The increased turf density and heat tolerance of the former likely minimized the visual effects of wear following foot traffic application.

Abbreviations: USGA, United States Golf Association

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Putting greens are exposed to multiple types of stress. Putting greens are being maintained at lower mowing heights than ever before and undergo traffic from equipment and golfers. Traffic affects turfgrass in two ways, either compacting soil or causing wear damage (Beard, 1973). The development of sand-based putting greens has minimized the negative effects of compaction. However, wear damage from traffic remains problematic on creeping bentgrass (*Agrostis stolonifera*) putting greens, especially with low mowing, high temperatures, and increased traffic from maintenance equipment. Wear injury on turf occurs from physical contact with scraping and tearing of foliar tissue, resulting in visible injury shortly after turf incurs traffic (Carrow, 1995). Spiked shoes worn by golfers result in significant wear damage to putting greens. Many researchers have demonstrated increased wear damage with metal-spiked golf shoes compared to non-metal spikes (Nikolai et al., 2006); however, research from the southeastern United States determined that both spike types created wear damage on heat stressed creeping bentgrass putting greens (Waltz and McCarty, 1999). As previously mentioned, putting greens experience increased mechanical stress when mowed at lower heights and rolled frequently to increase green speeds. These additional stresses combined with increased heat stress in the transition zone may decrease the wear tolerance of creeping bentgrass putting greens throughout the summer months. The objective of this study was to determine wear damage on creeping bentgrass cultivars under different mowing and rolling regimes.

Materials and Methods

This experiment was conducted at the University of Arkansas Research and Extension Center in Fayetteville on a USGA specification putting green (Hummel, 1993) from May to September 2010. Two creeping bentgrass cultivars (SR 1020 and PennG-2) were evaluated in separate studies. Each cultivar was divided into nine main mowing plots (12 ft by 18 ft) that were mowed six days per week with a Toro Greensmaster Flex 21 (The Toro Company, Bloomington, Ill.) at 0.100, 0.125, or 0.156 inch. Each mowing plot was divided into three 4 ft by 18 ft rolling plots (0, 3, or 6 times per week) applied with a Tru-Turf Greens Roller (Tru-Turf Pty. Ltd., Queensland, Australia).

Foot traffic was applied to half of each rolling plot five times between 22 June and 25 August 2010 by five researchers walking within each plot (4 ft by 9 ft) for two minutes. This was designed to simulate general foot traffic activity on putting greens. Each person walking in plots was equipped with a pair of FootJoy golf shoes (Acushnet Company, Fairhaven, Mass.) with non-metal spikes (Champ Spikes, Marlborough, Mass.). Once traffic treatments had been applied, wear was visually rated for each plot on a 1-9 scale with 1 being no turf visible, and 9 being no visible evidence of foot traffic. Wear ratings were recorded immediately following foot traffic application because wear injury is observed immediately, rather than over a long period of time as observed with compaction injury (Carrow, 1995).

Results and Discussion

Cultivar SR 1020 wear. Rolling frequencies were significantly different with respect to wear damage on each date foot traffic was applied (Fig. 1); however, mowing height alone was only significant on one rating date (Fig. 2). A mowing height by rolling interaction was observed on the first and last rating date (Fig. 3). Following the initial foot traffic application, plots mowed at 0.156 inch with no rolling had significantly less wear damage than plots mowed at 0.125 or 0.156 inch and rolled 6 days per week. This initial set of foot traffic data were compiled after plots had been maintained with mowing and rolling treatments for six weeks. The plots being maintained at the highest mowing height with no rolling exhibited more upright growth that may not have resulted in the visual damage (i.e., foot printing or spike marks) observed in plots that were rolled on a daily basis. Cooler temperatures early in the summer allowed plots maintained at lower heights to remain resilient to the traffic extremes to which the putting green was subjected.

As temperatures continued to increase throughout the summer months, plots receiving more traffic from rolling were more susceptible to wear damage from foot traffic (Fig. 1). By the end of the summer, the treatments continued to separate as expected. On 25 August, all mowing heights with no rolling and plots mowed at 0.156 inch with 3 rolls per week had significantly less wear injury than plots mowed at 0.100 or 0.125 inch and rolled 6 days per week (Fig. 3). The continually increasing environmental stresses along with mechanical stresses being applied appeared to diminish the resiliency of SR 1020 later in the summer.

Cultivar Penn G-2 wear. Significant differences in wear damage were observed on three of five foot traffic application dates. Both mowing and rolling treatments exhibited differences in wear damage on 7 July (Figs. 1 and 2). Plots maintained at 0.156 inch had significantly less wear than plots mowed at the two lower heights. Non-rolled plots also had significantly less wear injury than plots rolled 6 times per week. Both rating dates in August resulted in significant differences. The main factors, mowing height and rolling frequency, were significant on 11 August. Plots mowed at 0.156 and 0.125 inch had significantly less wear injury compared to plots maintained at 0.100 inch (Fig. 2). Similar to differences observed on the initial evaluation date, plots rolled 6 times per week had greater wear injury than plots that were not rolled. On the final evaluation date, all mowing heights with no rolling and plots mowed at 0.156 inch with 3 rolls per week had the least wear damage (Fig. 3). Plots maintained at 0.100 inch and rolled 6 days per week had the greatest wear injury. As conditions continued to worsen later in the summer, plots at the highest mowing height and non-rolled plots maintained a quality playing surface following foot traffic. In contrast, plots experiencing low mowing heights and daily rolling experienced greater wear damage, but recovered once conditions became favorable for cool season turf growth.

Conclusions

Although the two creeping bentgrass cultivars could not be compared to each other directly, it appeared that Penn G-2, the newer and improved cultivar, had slightly better overall wear tolerance than SR 1020 when subjected to low mowing and rolling treatments (Fig. 3). Wear tolerance differences were only observed on a single date in August for Penn G-2, whereas significant differences were detected on each date for SR 1020. The summer of 2010 brought excessive temperatures to all parts of the United States, which may have exacerbated wear injury on plots experiencing low mowing and consistent rolling. These data indicate that putting greens managed at extremely low mowing heights with frequent rolling throughout summer months in the transition zone will exhibit greater wear from increased golf rounds or commonly used walk-off areas. Continually changing hole locations and diverting walk-off traffic may minimize wear damage in highly traversed areas of putting greens.

Literature Cited

Beard, J.B. 1973. Turfgrass: Science and culture. Prentice-Hall Inc., Englewoods Cliffs, N.J.

Carrow, R.N. 1995. Wear stress on turfgrass. Golf Course Management 63(9):49-53.

Hummel, N.W. 1993. Rationale for the revisions of the USGA green construction specification. USGA Green Section Record 31(2):7-21.

Nikolai, T. A., D. E. Karcher, and J. C. Sorochan. 2006. Professional golfers conclude that spike design affects putting green quality. Online. Applied Turfgrass Science doi:10.1094/ATS-2005-1127-01-BR.

Waltz, F.C. Jr. and B. McCarty. 1999. Under traffic and heat, shoe change helps little. Golf Course Management 67(5):71-75.

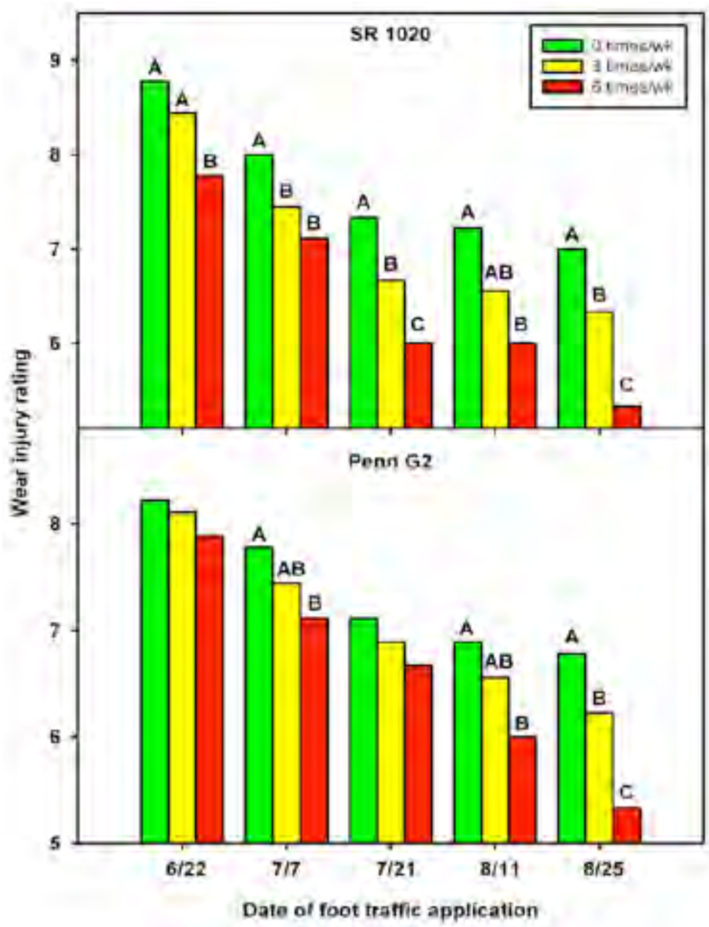


Fig. 1. Mean wear injury ratings for rolling treatments. Wear injury was rated immediately following traffic application on a 1-9 scale with 1 being completely thin, chlorotic and 9 being no visual evidence of foot traffic. Mean separation was conducted using least significant differences at α = 0.05. Means from a single date with different letters are significantly different at this level.

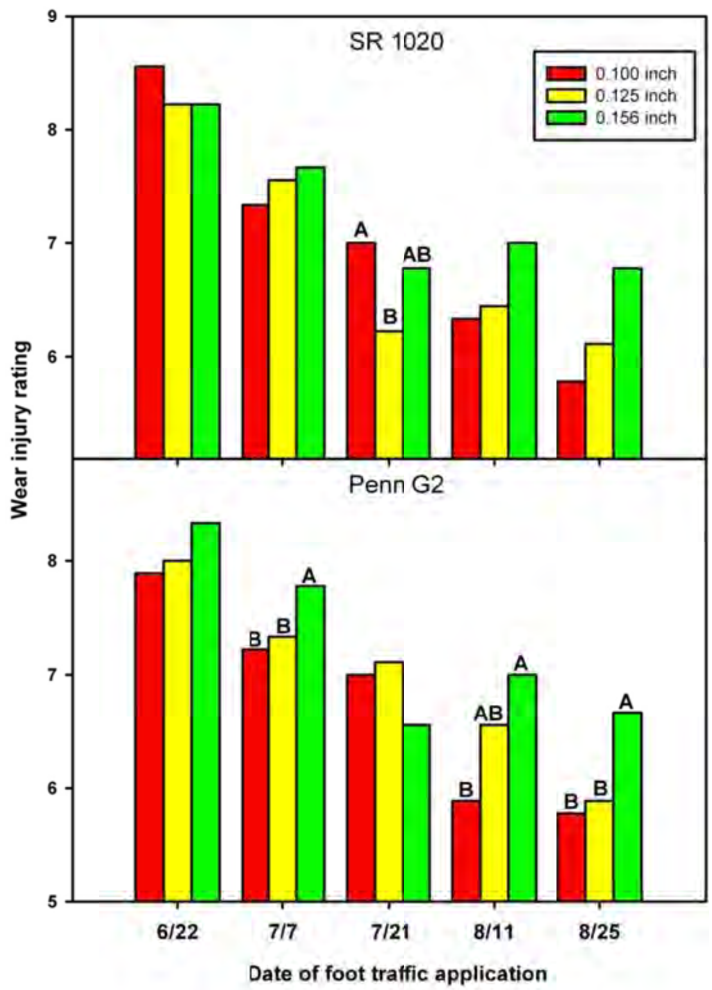


Fig. 2. Mean wear injury ratings for mowing height treatments. Wear injury was rated immediately following traffic application on a 1-9 scale with 1 being completely thin, chlorotic and 9 being no visual evidence of foot traffic. Mean separation was conducted using least significant differences at α = 0.05. Means from a single date with different letters are significantly different at this level.

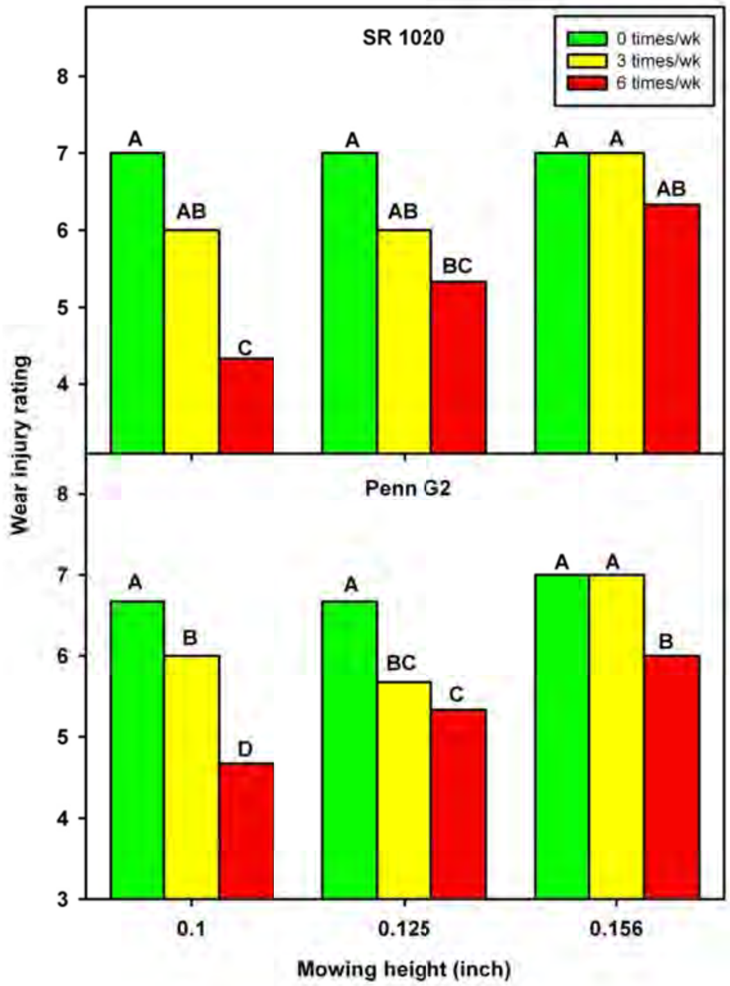


Fig. 3. Mowing height by rolling interaction from 25 Aug 2010. Wear injury was rated immediately following traffic application on a 1-9 scale with 1 being completely thin, chlorotic and 9 being no visual evidence of foot traffic. Mean separation was conducted using least significant differences at α = 0.05. Means for each cultivar with different letters are significantly different at this level.

Response of Tifsport Bermudagrass to Solitare Herbicide

John McCalla[1] and Mike Richardson[1]

Additional index words: *Cynodon dactylon*, sulfentrazone, quinclorac, postemergence, phytotoxicity

McCalla, J. and M. Richardson. 2012. Response of Tifsport Bermudagrass to Solitare Herbicide. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:94-96.

Photo by Mike Richardson

Phytotoxicity from Solitaire herbicide on Tifsport bermudagrass.

Summary. Several new herbicides have been released into the turfgrass market that contain the active ingredient, sulfentrazone. Sulfentrazone has shown both pre- and postemergence control of several species in the Cyperacea plant family which contains sedges and kyllinga. The objective of this study was to evaluate the tolerance of Tifsport bermudagrass to Solitare. In this study, four different rates (0.75, 1.0, 1.5, and 2.0 lb ai/acre) of a sulfentrazone+quinclorac combination herbicide (Solitare, FMC Corp., Philadelphia, Pa.) and one rate (0.75 lb ai/acre) of quinclorac (Drive, BASF, Research Triangle Park, N.C.) were applied to an established 'Tifsport' bermudagrass. Treatments were applied using a CO_2-propelled sprayer at 30 gallons per acre. Plots were 5 × 10 ft in size and plot design was a randomized complete block. Phytotoxicity of the various treatments was rated at 3, 7, 14, 21 and 28 days after treatment (DAT). At 7 DAT, all treatments had significantly more injury than the untreated control with the greatest injury observed with the highest rate of Solitare and Drive. There were also significant differences between treatments at 14 DAT, but only one treatment (Solitare at 1.5 lb) was significantly different from the untreated control. All observed injury was short-lived and turf had completely recovered by 21 DAT from all treatments.

Abbreviations: DAT, days after treatment

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

Bermudagrass (*Cynodon spp*.) is a warm-season grass that is widely used across the southern United States and throughout the transition zone. It has excellent drought and traffic tolerance and its recuperative potential makes it a popular choice for sports fields and golf courses. Hybrid bermudagrasses are often used in high-maintenance turf situations and were developed from a cross between *Cynodon dactylon* and *C. transvaalensis*. Tifsport is a hybrid bermudagrass cultivar developed by the Georgia Agricultural Experiment Station and the USDA-ARS that was released in 1995 (Beard and Beard, 2005). Tifsport is desirable because of its cold tolerance and fine leaf texture (McCarty, 2001). It was one of the top-rated cultivars in the 2002 and 2007 NTEP Bermudagrass Trials conducted at the University of Arkansas (Patton et al., 2008a, 2008b).

An important component to determine for any new herbicide is the desired turf on which the target grasses will respond to its application (Kopec and Gilbert, 2001). Sulfentrazone, a postemergence herbicide, is classified as a protox inhibitor which inhibits chlorophyll synthesis and ultimately membrane systhesis (Gardner, 2009). Research from several universities reported that sulfentrazone may offer control of yellow nutsedge. Because sulfentrazone has soil activity, it can be used for either pre- or postemergence sedge control. It is fast acting and has been shown to cause little injury on Kentucky bluegrass (*Poa pratensis*) and perennial ryegrass (*Lolium perenne*) (Gardner, 2009).

The FMC Corporation (Philadelphia, Pa.) recently released a product called Solitare®, which is a combination herbicide containing sulfentrazone and quinclorac. Quinclorac is a selective postemergence herbicide that can be used for both broadleaf and grassy weeds (Beard and Beard, 2005). It was introduced into the turfgrass market under the name Drive. This combination offers a broader spectrum of weed control than either chemical alone. However, early reports during preliminary testing indicated that some bermudagrass cultivars might be more sensitive to this combination than others. The objective of this study was to evaluate the injury response of Tifsport bermudagrass to different rates of Solitare and a single rate of quinclorac.

Materials and Methods

This study was conducted at the University of Arkansas Agricultural Research and Extension Center in Fayetteville, Ark. on a Tifsport bermudagrass area that was established from sod in 2005 on a Captina silt-loam soil. Plot size was 5 × 10 ft and the experimental design was a randomized complete block with four replications of each treatment. Four different rates of Solitare and one rate of Drive® (quinclorac) were applied on 2 July 2010. Solitare was applied at 0.75, 1.0, 1.5, or 2.0 lb ai/acre while Drive was applied at 0.75 lb ai/acre. Treatments were applied at a spray volume of 30 gallons per acre using a CO_2-propelled backpack sprayer and six nozzle boom with 10-inch spacings. Data collected included visual percent injury ratings at 3, 7, 14, 21, and 28 days after treatment (DAT).

Results and Discussion

The amount of injury observed on all rating dates (Fig. 1) was less than 25% and would likely be considered acceptable given the excellent weed control properties of these herbicides. There were no significant differences in injury between any treatments when compared to the control at 3 DAT, although some initial yellowing of the turf was observed on that date (Fig. 1). At 7 DAT, all treatments showed significantly more injury than the untreated control. Solitare at 2.0 lb and Drive at 0.75 lb ai/acre resulted in 22.5% injury at 7 DAT, whereas all other treatments were between 10% and 18% injury. While there were no significant differences among the treated plots at 7 DAT. At 14 DAT, Solitare at 1.5 lb ai/acre had significantly more injury than the control. All other treatments were similar. On the 21 and 28 DAT rating dates all injury had subsided and the 'Tifsport'had completely recovered.

Since injury was considered acceptable even at the high application rates and given the results of previous studies on the potential weed control possibilities with this combination herbicide, there is little reason for concern when using this herbicide on Tifsport bermudagrass (Gardner, 2009; Richardson and McCalla, 2010). Solitare offers turfgrass managers another herbicide option for weed control that contains two different modes of action that could potentially lead to better weed control and reduced applications.

Literature Cited

Beard, J.B., and H.J. Beard. 2005. Beard's Turfgrass Encyclopedia for Golf Courses, Grounds, Lawns, Sports Fields. Michigan State University Press. 463 pp.

Gardner, D.S. 2009. New options for golf course weed control: Several products have been released in recent years that give superintendents new options for control of difficult weeds. Golf Course Mgmt. 77(2):119-124.

Kopec, D.M., and J.J. Gilbert. 2001. Response of common bermudagrass turf to applications of sulfentrazone. Turf. Land. Urban IPM Res. Summ. pp. 95-99.

McCarty, L.B. 2001. Best Golf Course Management Practices. Prentice Hall, Upper Saddle River, N.J., 672 pp.

Patton, A., M. Richardson, D. Karcher, J. McCalla and J. Landreth. 2008a. 2002 NTEP bermudagrass trial–summary. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:33-36.

Patton, A., D. Karcher, M. Richardson, J. McCalla and J. Landreth. 2008b. 2002 NTEP zoysiagrass trial–summary. Arkansas Turfgrass Report 2007, Ark. Ag. Exp. Stn. Res. Ser. 557:47-51.

Richardson, M. and J. McCalla. 2010. Response of bermudagrass and zoysiagrass cultivars to Dismiss South and Solitare herbicides. Arkansas Turfgrass Report 2009, Ark. Ag. Exp. Stn. Res. Ser. 579:155-159.

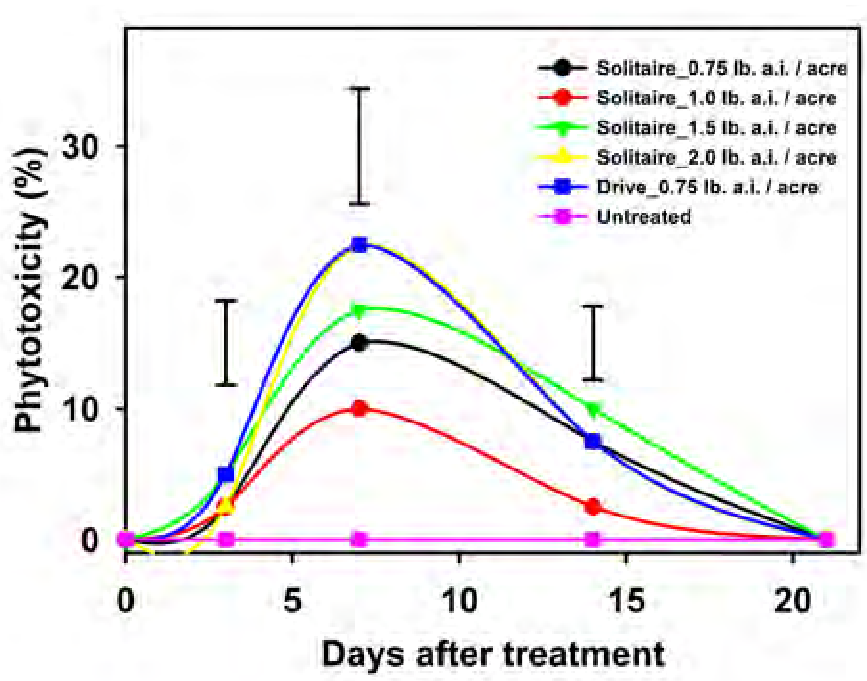


Fig. 1. Herbicide injury on Tifsport bermudagrass as affected by several postemergence herbicide treatments.

2010 Weather Summary for Fayetteville, Arkansas

Mike Richardson[1] and Doug Karcher[1]

Richardson, M. and D. Karcher. 2012. 2010 weather summary for Fayetteville, Arkansas. Arkansas Turfgrass Report 2010, Ark. Ag. Exp. Stn. Res. Ser. 593:97-98.

Photo by Mike Richardson

Hail covers one of the research putting greens at Fayetteville, Ark.

Summary. Summary data on air temperature and monthly rainfall totals at the University of Arkansas Agricultural Research and Extension Center, Fayetteville, Ark., are presented (Fig. 1) as a supplement to the 2010 Arkansas Turfgrass Report. Data were collected using a weather station (WatchDog, Model 2700, Spectrum Technologies, Plainfield, Ill.) located near the turfgrass research plots at the Fayetteville research station (36° 06' 04.06" N, 94° 10' 24.89" W, elevation 1266 ft). The end of the 2009 year (Richardson and Stiegler, 2010) and the early months of 2010 were cooler than normal, which resulted in significant winter injury on numerous turfgrass species. The remainder of 2010 was warmer than normal and several months experienced temperatures that were 5-6 degrees above normal. Although the rainfall total for the year was approximately 45 inches, which is 1.0 inch below normal totals for Fayetteville, most months had below-normal precipitation and the rainfall totals were significantly influenced by two major storms in July..

[1] University of Arkansas, Department of Horticulture, Fayetteville, Ark. 72701

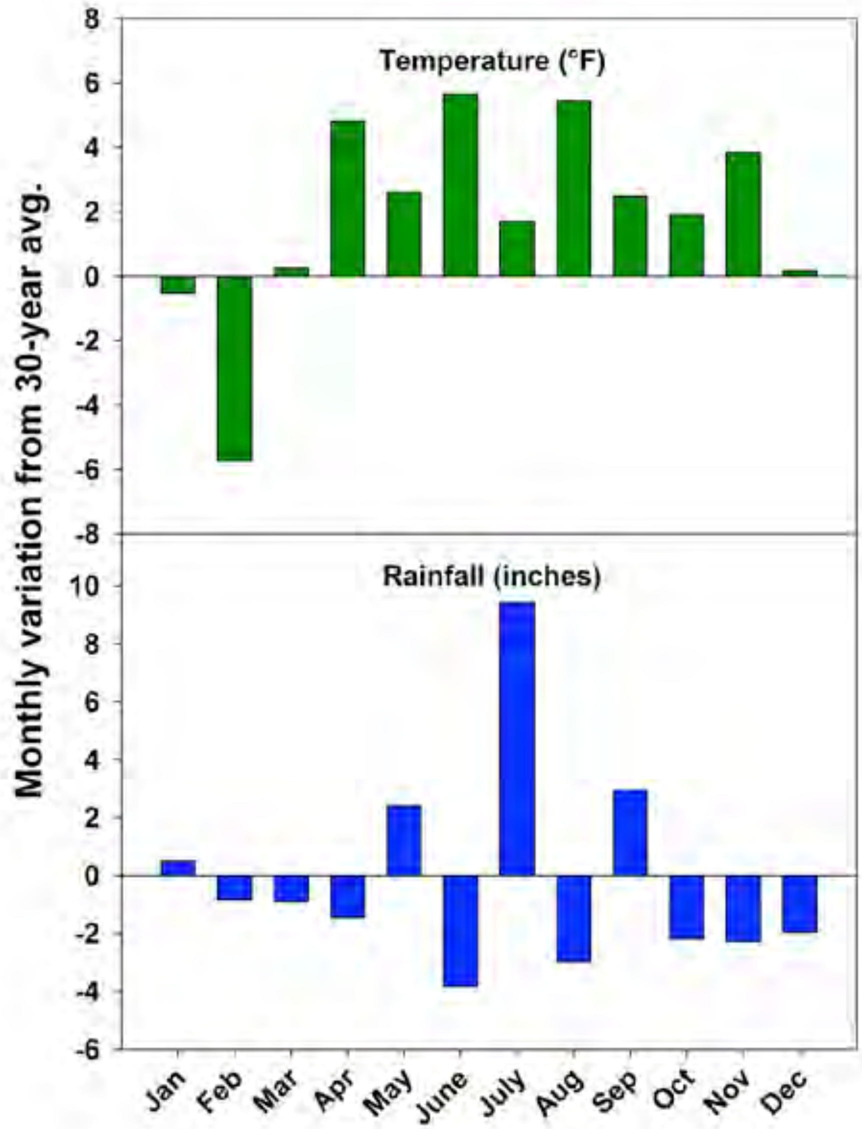


Fig. 1. Temperature and rainfall data for 2010 at Fayetteville, Ark. Data are presented as a deviation from the 30-yr average for the site.

UofA
DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System